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This Week

The research and service work being done by the Ethyl Corp. is something about which little is known. Joseph Geschelin spent some interesting hours at the laboratories and tells about it on page 250.

In this issue P. M. Heldt finishes the article on the future of engine design. Part One was in the Jan. 30 issue. Part Two you will find on page 256.

The British have contributed many interesting things to the automotive industry, not the least of which is the Morris 25-hp. engine. You will find mechanical drawings of it on page 265.

Capacity Output Near

March Production May Reach 550,000 Units; Higher Automobile Prices are Spring Possibility

By Harold E. Gronseth

With the spring selling season just around the corner, the automobile industry is straining to reach capacity production, a goal made possible by freedom from labor trouble and warranted by a strong retail demand and a deficiency in field stocks.

Barring further interruptions by strikes, full scale production is expected to be reached early in March, with an output for the month of some 550,000 units indicated. Assembly operations were resumed in some of the General Motors plants last Tuesday. Cadillac and a few Chevrolet plants were first to get under way, followed by Pontiac and Buick on Wednesday and Oldsmobile on Thursday. By the end of the week, eight of Chevrolet's 11 assembly branches were operating, with Tarrytown and Atlanta scheduled to resume on Monday and the Oakland plant next Thursday.

Initial production was light. The time required for distribution of key parts from Flint and Cleveland plants which had been closed by strike will prevent peak operations by all GM divisions until early next month, although some expect to reach capacity during the coming week. With only one week left of the current month, it is not expected that the corporation will be able to contribute much more than about 45,000 units to the industry's February total. Schedules for the balance of the industry indicate output of well over 300,000 units, so that the industry as a whole probably will turn out in the neighborhood of 350,000 vehicles this month. Even this would be 50,000 more units than were built in February last year.

The entire industry welcomed the settlement of the GM strike, which had an adverse psychological influence on car-buying generally, particularly in sections affected by plant closings. So

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GM and Union Start Bargaining

Daily Meetings Being Held to Consider UAW Demands; GM Divisions Nearing Capacity Output

Collective bargaining negotiations between General Motors and the United Automobile Workers Union were started Feb. 16, in accordance with the strike settlement pact, with both W. S. Knudsen and Homer Martin predicting that discussions would be concluded "within a reasonably short time."

All but 15 GM plants were back in operation the following day and the remainder were to reopen as soon as parts were available. Chevrolet cars began rolling off the Flint assembly line Tuesday, the first at that plant since Dec. 27. Orders had been released by the various divisions for more than $100,000,000 worth of materials.

Union demands being discussed in ferences now in session are:

1. Abolition of all piece-work systems of pay, and the adoption of straight hourly rates in their place.

2. Thirty-hour week and six-hour day, and time and one-half for all time worked over the basic work day and work week.

3. Establishment of a minimum rate of pay commensurate with an American standard of living.

4. Reinstatement of all employes who have been unjustly discharged.

5. Seniority based upon length of service.

6. Speed of production to be agreed upon by management and union committee in all GM plants.

Two sessions are held daily, from 10 a.m. to 12:30 p.m. and from 2:30 p.m. to 4:30 p.m. Representing the corporation in the first meeting were: W. S. Knudsen; C. E. Wilson, vice-president; Donaldson Brown, chairman of the finance committee; Stephen DuBrul, assistant to Brown, and Floyd O. Tanner, director of manufacturing. For the union were: Homer Martin; Wyndham Mortimer, first vice-president; Ed Hall, second vice-president; Walter N. Wells, third vice-president; John Brophy, CIO director, and Larry S. Davidow, UAW attorney. By agreement, both sides were to be represented in subsequent sessions by three represen-

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Wages at New Highs

Parts and Tire Makers Follow Car Builders' Pay Increases

New high wage levels are being established in the automobile industry. On the heels of increases made by Chrysler, General Motors and Packard, affecting close to 300,000 workers and amounting to $40,000,000 annually, came announcements of higher wage rates for some 39,000 workers at body and parts plants. Effective Feb. 15, Briggs Mfg. Co. increased wages on a merit basis for 27,000 employees; Murray Corp. added $2,000,000 to its payroll by advancing the minimum rates and giving

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Index on Press

The index to Vol. 75, June-December, 1936, of AUTOMOTIVE INDUSTRIES is now on press and will be available to subscribers in a few days. Expense of printing does not justify broadcast mailing of the index, but we will gladly send a copy to any subscriber on request.

Tax Chiseling Attacked

Congress Threatens to Withdraw Funds if Diversions Continue

Loss of millions of dollars in federal grants to the states for highway financing is threatened by growing sentiment in Congress against giving federal money to states which persist in misusing highway funds for general purposes and in neglecting highway development.

Such diversions exceeded $147,000,000 in 1935, with New York diverting the largest single amount, more than $58,000,000, to general purposes. The extent of the potential loss to the states may be measured by current federal aid grants totaling $200,000,000. Representative Wilburn Cartwright, of Oklahoma, and Senator Carl Hayden, of Arizona, co-authors of the Hayden-Cartwright Federal Aid Road Act under which the states have received millions of dollars in federal funds since 1934, recently stated that since the states appear to be disinterested in developing highways, they should no longer receive federal aid.

Threatened withdrawal of federal road aid renders acute the situation in New York and other states whose legislatures are proposing to use for general purposes instead of highways millions of dollars collected from gasoline taxes, registration fees, etc. The New York legislature now is considering a proposal to increase the gasoline tax to four cents and to use all of the expected additional revenue, $17,300,000, for general purposes. Withdrawal of federal aid would mean a loss of more than $10,000,000 to New York state alone.

U. S. Car Third in Monte Carlo Rally

In the Monte Carlo rally, Europe's most strenuous long-distance touring event, first place was won by a six-cylinder Delahaye, driven by Le Begue and Quinlin, with a French Talbot a close second. Third place went to a Buick, which M. Jacobs and T. De Boer drove 2300 miles from Stavanger, in Norway, to Monte Carlo, losing only 4.5 points to the winner. Fords finished seventh and ninth and another Buick was tenth.

The best performance with a feminine crew was made by Mrs. Molander, who brought a Plymouth over the 2400-mile route from Umea in Northern Sweden to the terminus at Monte Carlo.

Out of 121 starters, 81 completed the journey from distant parts of the Continent of Europe under mid-winter conditions. An average of 25 m.p.h. had to be maintained throughout the run, with an increase to 31 mi. for the last 600 mi. During the last 100 mi. there was a regularity test with a dead average of 37 m.p.h. checked by secret controls, and the final test was acceleration and braking. Stock cars with full touring equipment were allowed, but competition models in regular production were admitted.

New Company Formed to Operate Stoughton Plant

Stoughton Cab & Body Co., Stoughton, Wis., has been incorporated with $15,000 capital to take over and continue operation of the plant of the defunct Stoughton Co., manufacturing truck, trailer and cab bodies. M. T. Tiege has been elected president of the new firm. Among its principal customers are the Diamond T Co., Chicago, and the Springfield Body Co., Cambridge, Mass.

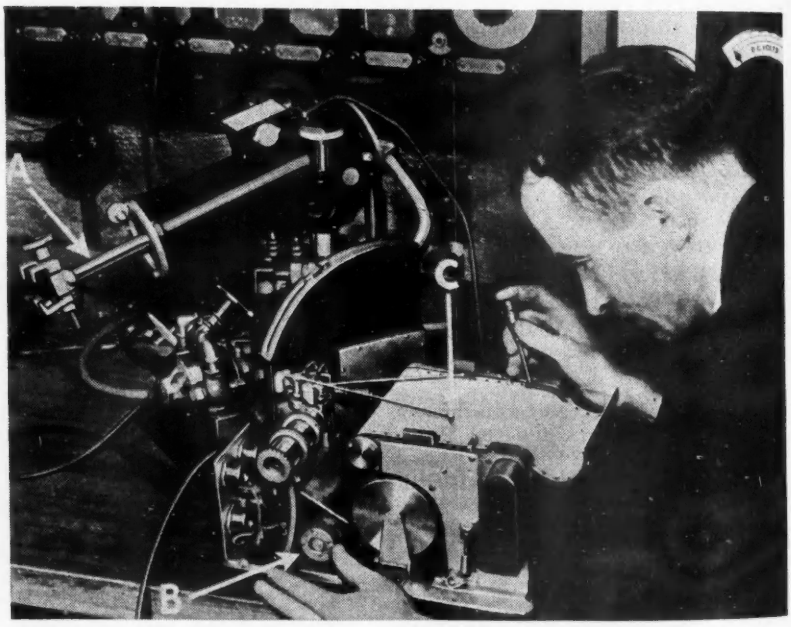
Millions for Aircraft

World Production to Rise 55% in 1937, Says Bendix Official

Approximately 3840 airplanes—1200 military and 2640 civil—will be produced in the United States during 1937, according to a survey of world aircraft production made by Howard S. Welch, vice-president of Bendix Aviation Export Corp. Such a total would represent an increase of 55 per cent over 1936 production figures of 1528 commercial planes and 1024 military planes reported by the Aeronautical Chamber of Commerce.

World expenditure for planes, navigational equipment, spare and replacement parts in 1937 will be around $911,000,000. With the added cost of maintenance of air corps personnel and expenses for such non-recurring capital items as airports and airways, the total world investment this year for all new heavier-than-air expansion will amount to approximately $1,750,000,000, Mr. Welch predicted.

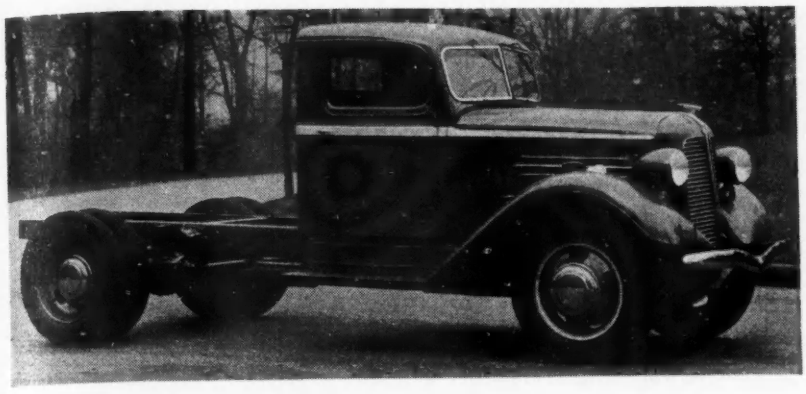
Of the estimated $911,000,000 equipment purchases in 1937, the Bendix figures indicate that $813,000,000 will be spent for fighting planes and the balance will go for commercial transport



GM Instrument Determines Relation Between Brake Pedal Pressure and Deceleration

The photograph reproduced herewith illustrates a testing instrument used by General Motors engineers to determine the relation between the pressure exerted on the brake pedal and the rate of deceleration produced thereby. The instrument is installed in a car and the plunger *A* is connected to the brake pedal. A trigger releases the plunger, which then applies the brakes under a definite pedal pressure. As a result of the deceleration produced, the weight *B* is thrown forward by its inertia, bringing into action a recording needle *C*. This needle moves over a waxed paper applied to a drum that is kept rotating at a uniform speed. From the line drawn on the paper the engineers determine the deceleration for different pedal pressures. Rex Albright, test engineer of General Motors' proving ground, is shown in the picture.

This test was used by Chevrolet engineers in the development of Chevrolet hydraulic brakes.



Streamlining is applied by the White Motor Co. to its low priced trucks. The new Indiana Model 86 is shown above

and other civil craft. European countries will spend $677,000,000 for both military and civil types, Asiatic countries, led by Japan, about $99,000,000; Canada and the United States, $112,000,000, and Latin America, $20,000,000.

Manufacturers of engine accessories, wheels and brakes, radio equipment and similar items will receive about 20 per cent of the world total spent for aircraft, or approximately $200,000,000.

Proposed Trailer Rules

National Safety Council Suggests Points for State Legislation

A memorandum on the regulation of house-type trailers has been issued by the National Safety Council over the signature of Donald S. Berry, assistant traffic engineer of the council's traffic engineering bureau. The various factors affecting the safety of house trailers are discussed in detail and the following suggestions for safety regulation by state laws are tentatively made:

1. Registration laws should be clarified to provide definitely for registration of house-type trailers. A provision requiring that house-type trailers be of a type or model approved by the department or be inspected before registration for conformance with state laws and the department's safety regulations is suggested.
2. The term "house-type trailer" or "trailer coach" should be defined in the Motor Vehicle Code as a special type of semi-trailer or trailer constructed for certain uses.
3. The brake requirements should conform in general to those of the Uniform Vehicle Code, which require brakes on new semi-trailers over 1500 lb. gross weight, and require that a vehicle or combination of vehicles shall be able to stop within 30 ft. from a speed of 20 m.p.h. In addition, it may be well to require brakes on house-type trailers which exceed 50 per cent of the weight of the tow car, or which will be used for transporting persons over the highway.
4. Coupling devices should be required to be of a rigid type and of a design approved by a state department. They should be supplemented by safety chains capable of holding the vehicle if the coupling should part. The connection should be required to be fastened to the frame of the towing vehicle.
5. Clearance lights, rear lamps, marker lights, reflectors and signaling devices should conform to state laws. If the existing laws are not adequate, follow the recommendations of the Uniform Vehicle Code.
6. Size and weight restrictions should conform to state laws or the recommendations of the Uniform Vehicle Code. Special consideration should be given to the allowable length for the combination. An additional weight restriction requiring that the weight of a house-type trailer shall not exceed that of a towing vehicle, may be desirable if special provision can be made for the heavier trailer coaches of the display type.
7. Rear-view mirrors should be required when necessary to provide adequate rear vision. This is generally already covered in the state laws.
8. If persons are to be transported in trailers over the highway, provision should be made for safety glass in the windows. A window which can be used as an emergency outlet would also be desirable.
9. Special maximum speed restrictions should probably not be imposed upon house trailer combinations, as long as the state equipment and performance requirements are adequate.
10. The general traffic regulations applying to all vehicles should apply to house trailers. This can be taken care of by defining the term, "house-type trailer" as a special type of semi-trailer or trailer, which are terms already defined as vehicles.

Indiana Trucks Restyled; White Adds Three Models

Indiana trucks Models 86 and 87, of 1½ and 2 tons rating, respectively, will hereafter be turned out with new fronts, the radiator grille and hood giving a streamlined appearance. The windshield is now of the sloping V type. There features are due to Count Alexis Sakhnoffsky, a well-known industrial artist who has been modernizing the external features of the products of the White Motor Co.

The White Motor Co. has added three more models to its already extensive line of trucks. Two of these, the 705 and 710, are of conventional design, with engines of 270 and 303 cu. in. displacement, respectively. The third new model, the 810, is of the cab-over-engine type and comes in wheelbases ranging from 97 to 193 in. It has a 303-cu. in. engine. Ratings of the three new models are as follows: 705, 1½-2 tons; 710, 2-4½ tons; 810, 2-4½ tons.

Chrysler Driveaway of 140 Cars

One of the largest driveaways ever staged by the Chrysler sales division of the Chrysler Corp. is scheduled for Feb. 23. At that time dealers from the territory headed by the Chrysler-Pittsburgh Co. will come to the factory and drive away 140 Chrysler cars.

Retail Financing Gained 53% in '36

Number of New Car Sales Financed Increased 45 Per Cent, Wholesale Credits Gained 21.5 Per Cent

The dollar volume of new car retail financing for the year 1936 was 53 per cent above that for 1935, according to the report of the Bureau of the Census, Department of Commerce, based on the data reported by 456 identical organizations. The total dollar volume for last year was $1,103,104,430 against $722,542,999 the previous year. The number of new cars financed at retail in 1936 was 1,900,324 compared with 1,312,351 in 1935, a gain of 45 per cent.

Wholesale financing reported for 1936 was $1,703,583,548 against $1,402,564,352 in 1935, an increase of 21.5 per cent.

The total retail financing, including both new and used cars, amounted to $1,715,981,150 last year, compared with $1,158,435,029 the previous year, an increase of 48 per cent.

The accompanying table gives further details of automobile financing for 1936.

Year and Month	Wholesale Financing Volume in Dollars	RETAIL FINANCING											
		TOTAL			NEW CARS			USED CARS			UNCLASSIFIED		
		Number of Cars	Total Amount	Per Car	Number of Cars	Total Amount	Per Car	Number of Cars	Total Amount	Per Car	Number of Cars	Total Amount	Per Car
December 1936	$185,578,504	347,339	148,100,585	426	165,823	97,119,776	586	179,358	50,074,883	279	2,160	905,926	419
November, 1936	133,554,848	272,051	113,747,212	418	124,120	73,202,903	590	146,238	39,876,967	273	1,693	667,342	394
December 1935	154,382,330	260,764	103,200,806	396	120,301	67,423,356	560	137,962	34,779,967	252	2,501	997,483	399
Total, 1936	1,703,583,548	4,263,761	1,715,981,150	402	1,900,324	1,103,104,430	580	2,336,617	603,206,249	258	26,820	9,670,471	361
Total, 1935	1,402,564,352	3,125,537	1,158,435,029	371	1,312,351	722,542,999	551	1,768,125	419,463,685	237	45,061	16,428,145	365

Higher Tire Prices?

Wage Increases, Firm Rubber Market, May Bring New Price Jump

The tire industry's Feb. 15 wage increase brings nearer, observers assert, another general tire price increase. Prices were last advanced Jan. 18, the increase averaging six per cent. This was insufficient to cover increases in raw material costs, the value of crude rubber per tire, on the average, having increased more than $1.00 in the last 90 days.

At the time the six per cent price increase was enforced, the industry needed still higher prices. However experience has taught tire manufacturers that a more stable price structure can be maintained through a series of moderate increases rather than in one or two major price jumps. The next price advance very probably will come early in March and, in view of the recent wage boosts, may not exceed six per cent.

Crude rubber prices seemed to have been pegged at the 21-cent average. During the General Motors strike they softened slightly. The industry expected the termination of the automobile strike to cause crude prices to stiffen substantially. Instead, however, the rubber market was only slightly higher and then weakened again, sinking back to the 21-cent average. The industry takes this as an indication that crude prices may not soar as had been earlier feared.

Tire inventories are heavier than for many years and now exceed 20,000,000 casings. During the last six months the industry has consistently added an average of a million tires per month to inventories, and has scattered these stocks throughout the country. Tire stocks at the start of the year were at least 18,500,000 including about 7,500,000 tires in the hands of all distributors. During January, due largely to the cessation of General Motors tire orders, the industry increased its inventory position by at least 1,500,000 casings. With such a substantial inventory position, a further price increase would materially improve the earning power of all tire manufacturers and enable them to increase profit margins on heavy stocks already manufactured with cheaper priced rubber and not yet moved onto distributors' shelves.

:SLANTS:

SAFEST PACKARD—*Believed to be one of the most completely protective armored cars ever built, a Packard Twelve sedan-limousine has just been completed for General Tiburcio Carias Andino, president of the Republic of Honduras. It will, it is said, resist fire from pistol, sub-machine gun, bomb or even high powered rifle. In outward appearance the car is no different than any other Packard Twelve sedan-limousine. However, there is an inner shell of armor plate ¼ in. thick which is so hard surfaced that it can neither be sawed, filed nor drilled. This steel plate is hidden between the outer steel of the body and the inner dark blue leather trimming. Windows are of bullet resisting glass 1¼ in. thick.*

GOODYEAR DAY—*The Goodyear colors will fly over the Great Lakes Exposition in Cleveland, June 12, when Goodyear Day is to be observed. Twelve thousand employes of the tire and rubber company, with a 70-piece boys band and the Goodyear chorus, will participate in the celebration. Rubber costumes will play a big part in the "Aquacade" to be produced as the entertainment highlight by Billy Rose, of "Jumbo" and "Casa Manana" fame. The "Aquacade" will include, it is said, 500 beauties who can dance, swim and sing on—or in—the 3,000,000-gal. stage with a 40-ft. water curtain.*

DISASSEMBLY LINE — *The Ford Motor Co.'s assembly line at Louisville, Ky., went into reverse after flood waters had receded. A lot of 325 new cars which had been damaged by the flood were put back on the end of the line they had come off and disassembled as they were run backward. Parts that could be salvaged were returned to the Ford factory in Detroit; the rest of the cars, such as the upholstery, was junked.*

H. SYDNEY SNODGRASS has been appointed manager of the motor coach division of Gar Wood Industries, Inc. He was formerly the division's chief engineer and assistant manager.

STANLEY E. KNAUSS has resigned as manager of the motor coach division of Gar Wood Industries, Inc., and after an extended stay in Florida expects to establish his own business.

W. E. BULLOCK, who has been with the AP Parts Co., Toledo, since 1931 in various sales capacities, has been appointed vice-president in charge of sales of the company.

S. E. SANGSTER has joined Palace Travel Coach Corp. as publicity director. He is widely known as a veteran in automotive and travel publicity fields and since 1935 was publicity head for Covered Wagon Co.

W. LEDYARD MITCHELL, vice-president of the Chrysler Corp. in charge of international sales, has sailed from New York for an extensive tour of Central and South America, where he will hold conferences with Latin American distributors.

HYMAN BORNSTEIN, chief chemist and metallurgist, Deere & Co., Moline, Ill., has been nominated vice-president of the American Foundrymen's Association on the slate of new officers subject to election at the convention at Milwaukee, May 3-7.

FERDE JEHLE, formerly with the White Motor Co., and an active member of the Cleveland Section, SAE, is now director of the laboratory of the Hoffman Specialty Co., Stamford, Conn.

Yellow Coach Profits

Tenfold Increase Shown Last Year; Higher Incomes General

Yellow Truck & Coach Manufacturing Co. and subsidiaries in a preliminary report for the year ended Dec. 31, 1936 (subject to final audit adjustments), show net profits of $5,089,024 after depreciation and taxes, comparing with net profit of $503,000 during the previous year. Net sales for the year totaled $59,426,329 against $35,856,799. Directors of the company have declared a quarterly dividend of $1.75 per share on the preferred stock, payable April 1 to stockholders of record March 15.

Net profit of the **Motor Wheel Corp.** for the year ended Dec. 31, 1936, after deduction of taxes was $1,800,933 compared with $1,087,979 the previous year. Sales totaled $3,511,853 last year against $2,365,229 in 1935.

Gemmer Manufacturing Co. and wholly owned subsidiary reports net profit of $405,364 for the year ended Dec. 31, 1936, against net profit of $220,214 the previous year.

Federal Mogul reports a net profit of $398,086 equal to $2.34 a share for the year ended Dec. 31, 1936, compared with net profit of $209,264 the previous year.

Goodyear Tire and Rubber Co. of Canada, Ltd., reports for 1936 net profits of $1,516,344 against $1,445,198 in 1935.

Minneapolis-Moline Power Implement Co. and subsidiaries show a consolidated net income of $739,149 for 1936 compared with net income of $170,678 in 1935. Sales increased last year to $12,027,546 from $9,061,185 the previous year.

Hayes Body Corp. and subsidiaries in the quarter ended Dec. 31, 1936, had a net loss of $51,804 compared with a net profit of $36,413 in the like quarter of 1935. Net loss for the year 1936 was $110.317 after all charges.

Stutz Motor Car of America reports for the fiscal year ended Oct. 31 a net loss of $263,740 against net loss of $239,902 in the preceding year.

Ainsworth Manufacturing Co. and subsidiaries report for 1936 a net profit of $962,726 compared with net profit in 1935 of $987,816.

Amos Northup

Amos Northup, chief designer for the Murray Corp. of America, and one of the foremost body designers in the world, died in Detroit, Feb. 13, from injuries suffered when he slipped and fell on an icy street. He was 48 years of age.

Mr. Northup had been with Murray for the past 10 years and was previously with Willys-Overland Motors, Inc. He is credited with being the originator of the town car type of body and with having been the first to place bright color combinations on automobiles.

Wages at New Highs

(Continued from page 239)

a five cents an hour increase, affecting 10,000 employees; higher rates at Ainsworth Mfg. Co. will affect 2000 workers. The trend is toward a minimum hourly rate of 75 cents for men and 65 cents for women.

The following announcement was made by Murray Corp.:

"Effective Feb. 16 in all Murray Corp. plants, including Jenks & Muir Cushion Spring Division, the minimum rate will be 75 cents per hour for male employees who have had six months'

continuous service with the company and 65 cents for female employees of the same service. All employees now receiving these minimums or more will receive an increase of five cents per hour. Minimum hiring rate for men will be 65 cents and for women 55 cents per hour. Employees will be advanced from these hiring rates to the minimum rates as rapidly as skill is acquired but in no case will this period exceed six months."

The following notice was posted in Briggs plants:

"We are pleased to announce an increase in pay for all employees now working on an hourly rate. All increases are effective today, Feb. 15, 1937. Your foreman will notify you of the amount of your increase as soon as raise slips can be made out." No estimate was available of the amount the payroll would be increased annually by this raise.

Announcement of higher rates to be paid by Ainsworth was made by the United Automobile Workers Union.

The Packard wage increase of five cents an hour was announced officially Feb. 12 and will affect 13,000 employees, adding $2,000,000 annually to the payroll.

Wage increases of from five to eight cents per hour and amounting to approximately $3,000,000 annually went into effect Feb. 15 for nearly 40,000 Akron rubber workers and tire builders. The Akron wage increase was led by the Firestone Tire & Rubber Co. and was immediately followed by similar action by Goodyear, Goodrich and General Tire companies.

Firestone officials in announcing the wage increases and establishment of minimum wage levels of 75 cents an hour for men and 65 cents an hour for women, stated it was the sixth wage increase given Firestone workers since 1933. The last general wage increase for the tire industry was last May following an advance in tire prices.

Hourly pay rates have been increased five cents an hour by the Detroit Forging Co., while piece-work rates were raised proportionately.

Wage increases for employes of Budd Wheel Co. and E. G. Budd Mfg. Co. were announced simultaneously in Detroit and Philadelphia this week. The 5450 workers in the Philadelphia plant received a 7 per cent increase effective Feb. 16 which will amount to more than $1.000,000 annually. The Budd Wheel increase covering 3500 workers, became effective Feb. 15 and will add $350,000 yearly to the payroll.

Bendix Aviation to Build Plant at Teterboro, N. J.

Bendix Aviation Corp. this week confirmed reports that the company was planning to build a plant to cost several million dollars at Teterboro, N. J. It is understood that the company will manufacture aviation instruments, and that activities of the plant at Franklin, Ind., will be moved to Teterboro.

Studebaker Birthday

South Bend Fetes 85th Anniversary; Reeves Praises Management

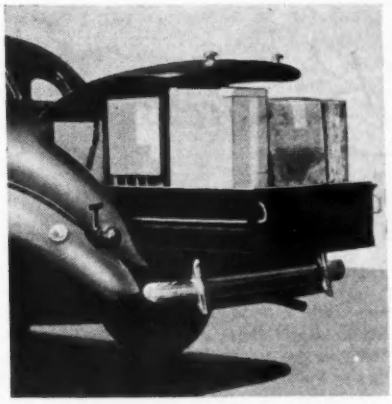
Contributions of the Studebaker Corp. to the progress of the automobile industry were acclaimed in South Bend, Feb. 15, by Alfred Reeves, vice-president and general manager of the Automobile Manufacturers Association.

Speaking at a luncheon of motor executives and South Bend business leaders on the occasion of the corporation's 85th anniversary, Mr. Reeves congratulated the South Bend concern not only upon its record as a pioneer but also upon the prestige which it has achieved and maintained throughout the world.

"The best possible assurance that Studebaker will continue to share in the industry's expansion is the combination of able management and loyal workers producing fine products which have won for themselves the ready public acceptance currently enjoyed," Mr. Reeves declared.

Notwithstanding the progress of the industry last year, there are a number of real problems ahead which require solution, continued Mr. Reeves. As the first of these major problems confronting the industry, he cited that of traffic accidents and congestion, taking occasion to praise Paul G. Hoffman, Studebaker president, for his service as chairman of the association's committee in charge of the industry's expanded safety program. "Through the committee headed by Mr. Hoffman the combined automobile industry is providing necessary financial sinews to enable some 14 national organizations to carry on effective work in the solution of this major problem."

Another problem which received Mr. Reeves attention was that relating to excessive taxation of highway users and the tendency of legislators in some States to use special motor vehicle tax funds for other than highway purposes.



The Utility Coupe Pick-Up, introduced as part of the Terraplane line of commercial cars, may be changed from a passenger to a business car by sliding out a steel box, 49½ in. long, 38 in. wide, 11⅝ in. deep and having a loading height of 32 in. under the rear deck door.

License to Build Planes Sought

Australian Group Negotiates with North American and United Aircraft for Rights

Australian interests are seeking to make arrangements with North American Aviation, Inc., for use of the American company's designs for war planes to be built by a proprietary stock company in Australia in connection with Britain's comprehensive plans for national defense.

Other American companies also have been approached, including United Aircraft Manufacturing Corp., as the Australians have indicated a desire to have the planes powered with Pratt & Whitney Wasp engines.

Because the activities of the Australian interests are, in effect, part of the British plans for national defense, negotiations to date have been surrounded with the utmost secrecy.

General Motors Corp. is the largest individual owner of North American Aviation stock.

North American Aviation has developed designs and models for several types of military planes. It was because of this that Wing Commander Earl J. Hackett came from Australia last summer and conferred with officials of the company in New York. Following these conferences he visited the corporation's plant in California. He also made contact with United Aircraft Manufacturing Corp. officials.

Before returning to Australia to report to associates, he expressed himself as highly pleased with models, planes and engines he had inspected. Recently executives of the American companies were informed that the Australian group would soon send another representative to this country to take up the negotiations.

The military planes developed by North American Aviation cost about $25,000 each. The Australians explained that due to the urgency of beginning production at the earliest possible moment, they preferred to use plans of the American company rather than take the time to develop plans of their own.

Should an agreement be reached, it was said, the likelihood is that some of the plane parts would be produced in this country and sent to Australia to be assembled. It also was said that any agreement for use of American plans would involve a cash payment for the license privilege and royalties on planes produced and sold.

Business in Brief

Written by the Guaranty Trust Co., New York, exclusively for AUTOMOTIVE INDUSTRIES

General business activity was well maintained last week, despite the effects of strikes, floods, and political uncertainties. Conditions in the heavy industries were particularly encouraging, while sales volumes in wholesale and retail lines continued favorable. Confidence has been strengthened as a result of the settlement of the maritime and automobile strikes and the absence of wide-spread damage from the flood in the lower Mississippi.

Carloadings Slightly Higher

The movement of railway freight increased moderately during the week ended Feb. 6. Loadings during that period totaled 675,026 cars, as against 659,790 cars in the preceding week and 621,686 cars in the corresponding period last year.

Power Output Up 12%

Production of electricity by the electric light and power industry of the United States for the week ended Feb. 6 was 12.1 per cent larger than in the similar period a year ago. This gain was somewhat smaller than those reported in the few weeks immediately preceding. A week earlier the gain above last year's corresponding figure was 13.3 per cent; two weeks earlier, 15.7 per cent; and three weeks earlier, 14.9 per cent.

Lumber Shipments at Low Level

The lumber industry during the week ended Jan. 30, the last full week of the maritime strike, stood at 46 per cent of the 1929 weekly average of production and at 58 per cent of 1929 shipments. Other factors tending to hold production at a low level were flood conditions and adverse weather. For the third consecutive week, new orders were more than 40 per cent in excess of production.

Crude Oil Output at New High

Average daily production of crude petroleum in the week ended Feb. 6 reached a new high record, standing at 3,220,750 bbl., showing a gain of 26,700 bbl. above the output for the preceding week and comparing with the figure of 3,068,600 bbl. calcu'ated by the Department of the Interior to be the total of the restrictions imposed by the various oil-producing States for February.

Fisher's Index

Professor Fisher's index of wholesale commodity prices for the week ended Feb. 13 stands at 90.7, as against 90.4 a week before, 90.4 two weeks before, 90.2 three weeks before, and 90.7 four weeks before. The current figure is nearly two full points above the highest reached in 1936.

Federal Reserve Statement

Federal Reserve bank credit outstanding increased $14,000,000 during the week ended Feb. 10, although there was no change in the amount of bills discounted, bills bought in the open market, or United States Government securities. The monetary gold stock rose $23,000,000, money in circulation $12,000,000, and member bank reserve ba'ances $13,000,000. Reserve balances of member banks on Feb. 10 were estimated to be approximately $2,180,000,000 in excess of legal requirements.

SAE National Aeronautic Meeting in Washington

The program of the National Aeronautic Meeting to be held at the Mayflower in Washington March 11-12 has been announced. The meeting is sponsored by the SAE and its Washington Section with the cooperation of the Aeronautical Chamber of Commerce of America, the Air Transport Association of America, the American Society of Mechanical Engineers and the Institute of the Aeronautical Sciences. The detailed program follows:

Thursday, Mar. 11

10:00 a.m. *Fuels and Lubricants*

A. L. BEALL, Chairman

What an Octane Number Is Worth in the Air—D. P. BARNARD, Standard Oil Co. of Indiana.

Engine and Laboratory Tests of Stability of Aviation Oils—O. C. BRIDGEMAN, National Bureau of Standards.

1:30 p.m. *Inspection Trip*

Inspection trip through the National Bu- reau of Standards Laboratories.

8:00 p.m. *Vibration*

S. J. ZAND, Chairman

Measurement of Vibration in Flight—C. S. DRAPER and G. P. BENTLEY, Massachusetts Institute of Technology, and H. H. WILLIS, Sperry Gyroscope Co.

The Vibration Problems in Propeller Designing — F. W. CALDWELL, Hamilton Standard Propeller Co

Friday, Mar. 12

10:00 a.m. *Practical Aerodynamic Problems*

PETER ALTMAN, Chairman

Laminar and Turbulent Boundary Layers as Affecting Practical Aerodynamics—E. N. JACOBS, National Advisory Committee for Aeronautics, Langley Field.

The Practical Application of Fowler Flaps —H. D. FOWLER, Glenn L. Martin Co.

10:00 a.m. *Engines*

ROBERT INSLEY, Chairman

Carburetion of Engines for Long Range Flight—W. L. LOSSON, Wright Aeronautical Corp.

The Design of Metal Fins for Air-Cooled Engines—A. E. BIERMANN, National Advisory Committee for Aeronautics, Langley Field.

Aircraft Engine Reduction Gears—FORD L. PRESCOTT, U. S. Army Air Corps, Wright Field.

2:00 p.m. *Aircraft Design*

H. J. E. REID, Chairman

Interior Finish of Transport Airplanes—H. O. WEST, United Air Lines.

Design Trends as Affecting Ground Facilities—L. L. ODELL, Pan American Airways (under the sponsorship of the Aeronautics Division of the A.S.M.E.).

2:00 p.m. *Engines*

VAL CRONSTEDT, Chairman

Flexible Exhaust Valve Seats—S. D. HERON, Ethyl Gasoline Corp., and A. L. BEALL, Wright Aeronautical Corp.

Determination of Service Ratings for Aircraft Engines—R. F. GAGG, Wright Aeronautical Corp.

Lubrication and Cooling Systems for Aircraft Engines—WELDON WORTH, U. S. Army Air Corps, Wright Field.

Friday evening, Mar. 12

NATIONAL AERONAUTIC MEETING BANQUET

Reception 6:30 p.m.
Dinner 7:00 p.m.

LIEUT. COL. B. O. LEWIS
Chairman, Washington Section
C. H. CHATFIELD, Toastmaster
H. T. WOOLSON, President, S.A.E,
European Aviation Engines
ARTHUR NUTT, Wright Aeronautical Corp.

Chrysler Offers Custom Town Car

A custom-built town car is now available in the Chrysler Royal line. The car is built on a wheelbase of 133 in. and has a 100-hp. engine. The passenger compartment is equipped with two auxiliary seats. A removable canopy may be spread over the driver's seat in bad weather.

Packard Renews Astaire Show

The Fred Astaire show, sponsored by the Packard Motor Car Co., has been renewed for a spring cycle. The third series of the Tuesday night NBC-Red network full hour programs will be inaugurated in March.

40 Years Ago

with the ancestors of AUTOMOTIVE INDUSTRIES

The Marseilles-Monte Carlo Race

The three days' race for amateurs (*chauffeurs*, as they are termed in French), between Marseilles and Monte Carlo, was run early in February under distressing weather conditions. The roads were in bad condition and a strong and disagreeable wind blew during the entire course, but notwithstanding these obstacles better time was made than in the Paris-Marseilles-Paris race last fall.

The course of 150 mi. was divided into three stages, the first 95 mi., the second about 45 mi. and the third about 10 mi.

The competing vehicles were divided into two classes, motor carriages and motor cycles. Thirty-seven vehicles started, 28 carriages and nine cycles.

Count de Chasseloup-Laubat who drove a De Dion steam tractor arrived at the terminal first, having made an average of 21 m.p.h. M. Lemaitre, who operated a vehicle manufactured by Panhard & Levassor, made over 20 m.p.h.

—From *The Horseless Age*, February, 1897.

GM's Canadian Plants Avoided Strike Effects

Cars are still rolling off the lines at General Motors of Canada, Ltd., plants in Canada despite the scarcity of body stampings. Tension was relieved from time to time by the ingenuity of the Canadian management which is reported to have brought stampings from as far away as the Pacific coast to keep production moving. It is reported that sufficient material to permit production of 2600 Chevrolets was obtained some weeks ago.

Termination of the strike of General Motors employes in the United States "probably means the Canadian plant at Oshawa, Ont., will avoid a shutdown," Harry J. Carmichael, general manager of GM of Canada pointed out. Mr. Carmichael expressed the belief the flow of materials, halted by the strike, would be resumed before present supplies are exhausted.

Maintenance Trade to Have Big Show Program This Year

The 1937 maintenance show season began this year with several important cities in the lineup for the first time. San Antonio wholesalers lead off the list with their exhibits which were scheduled to run from Feb. 4 to 7, inclusive; to be followed by the show in Toronto, Feb. 8 to 11.

Plans for a show in New York, which is expected to attract the maintenance trade from all parts of the metropolitan area, including Long Island and New Jersey, have been announced by a committee headed by Walter Hall of the U. S. Air Compressor Co. The dates have been set for April 21-23 and the Port of New York Authority building will be the site.

Other newcomers this year are Boston and Minneapolis, where local Booster clubs have taken over the sponsorship in each instance. Boston dates have been set for April 1 to 4 at the Boston Garden Exposition Hall, according to H. U. Tassinari, chairman, and Minneapolis, April 8 to 11 in the Minneapolis Auditorium, Wallace C. White, chairman. The schedule of shows follows:

Philadelphia	Mar. 2-5
Pittsburgh	Mar. 9-12
Kansas City	Mar. 25-28
Boston	Apr. 1-4
Minneapolis	Apr. 8-11
Buffalo	Apr. 13-16
New York	Apr. 21-23
Chicago	Apr. 24-28
San Francisco	May 20-23

British War Office to List Private Trucks

Every commercial motor vehicle in Great Britain is to be inspected by the War Office to discover its best use in war time, it has been announced. Every garage is to receive an official visit by the Inspectorate of Supplementary Transport, a department of the War Office that will prepare a complete record of civilian transport than can be taken over by the Government in the event of a national emergency. Private cars are not to be inspected but under the Army Act, the Government has power to take them over in the event of war.

The War Office has been responsible in the past for a census of all horse vehicles in the country, the last census being published in 1934. Owing, however to the increasing mechanization of the army, the necessity has arisen for more complete knowledge of civilian motor transport.

Libbey-Owens Ford Gets Rights To New British Glass Process

Net earnings of Libbey-Owens-Ford Glass Co. for 1936 were $10,379,538 or $4.14 a share on 2,503,168 shares common after all charges. The directors have declared a dividend of 75 cents a share payable March 15 to holders of record March 1.

John D. Biggers, president, reported average employment was 7205 for 1936 contrasted with 6979 in 1935. Payrolls increased $1,563,101 last year over previous year in spite of fact that plants were closed a greater part of December.

Acquisition of the American patents for the Pilkington flow process of casting plate glass blanks was announced at a cost of $610,000, which together with other patent expense, was charged to 1936 operations. The process of casting a continuous ribbon of glass 130 in. wide was developed by Pilkington Brothers, Ltd., of England.

Census Shows Great Diesel Increase

From 1473 Engines Built in 1931, Production Rose to 6919 in 1935, with Total Horsepower of 958,485

The production of Diesel and semi-Diesel engines in the United States increased from 1473 with a total horsepower of 264,037 in 1931, to 6919 with a total horsepower of 958,485 in 1935, according to a special report based on data collected in the recent biennial Census of Manufactures released this week by William L. Austin, Director, Bureau of the Census, Department of Commerce.

The accompanying table gives the 1935 figures in detail, by types of engines, with comparative totals for 1931. All figures for 1935 are preliminary and subject to revision.

Production of Diesel and Semi-Diesel Engines, by Number, Value, and Horsepower in Detail, 1935 and 1931, and by type, 1935

	Number of establishments	Number	Total Rated Horsepower Capacity	Value	Number, by hp. capacity (rated or normal, not overload) up to 400 hp					
					Under 10	10 or more but under 20	20 or more but under 50	50 or more but under 100	100 or more but under 200	200 or more but under 400
Total: 1935[2]	47	6,919	958,485	$18,245,359	78	230	1,608	2,317	2,156	359
1931	42	1,473	264,037	11,811,975	65	106	287	297	331	213
BY TYPE: 1935										
Diesel (compression-ignition), total	42	4,854	802,392	15,470,448	74	209	660	1,442	1,816	292
MARINE:										
For direct connection to propeller shaft	24	868	85,036	3,277,338	2	5	363	164	189	116
For electric-drive and auxiliary use	10	255	31,163	1,659,245	4	65	110	23	16	15
OTHER DIESEL:										
Stationary	31	2,478	509,489	7,282,913	68	139	387	1,131	550	130
Other (tractor and aircraft: railway Diesel-electric)[3]	12	1,153	176,704	3,050,952	..	..	..	124	1,061	31
Semi-Diesel (surface-ignition—hot-spot, hot-bulb, etc.)[4]	12	2,065	156,093	2,774,911	4	21	748	875	340	67

[1] No Diesel or semi-Diesel engines rated at 5,000 horsepower or more were reported.

[2] The difference between the net total number of plants engaged in the manufacture of Diesel and semi-Diesel engines, 47, and the sum of the numbers engaged in manufacture of the several types listed, 89, is due to the fact that 42 of the plants either made two or more types of Diesel or manufactured both Diesel and semi-Diesel engines.

[3] Not including Diesel engines made and installed by same establishments.

[4] Separate data were collected for industrial portable and stationary engines and for other types, but it was necessary to combine them in order to avoid disclosing approximations of the production reported by individual establishments.

Broadway Portrays "Flint"

Dramatization of a Sitdown Strike in an Automobile Town Strongly Tinged with Propaganda

By Herbert Hosking

Just five days after the truce of Flint, Broadway saw in "Marching Song" a stage dramatization of a sitdown strike in "an automobile town." On the opening night, Feb. 17, the piece played to a packed house, recruited largely from the more literate labor groups and got an ovation which seemed to embarrass author John Howard Lawson by its proportions. Action of the play begins several months after an unsuccessful strike in a company-owned automobile manufacturing town which is labelled Brimmerton for the uses of the play, but which quite a few devices, including a map, indicate as closely related to Flint, Mich.

A number of workers who have failed to regain their jobs after the strike are "holed in" for the winter at an abandoned factory at Brimmerton, and are inclined to be bitter about the futility of the union. Eviction of a worker and his family from their home galvanizes the union into new activity. The sitdown technique is applied, and from then on the action becomes a recital of just about all the standard grievances of organized labor. Our principal objection to the play as a piece of propaganda is that it leaves a nasty implication that a lot of the things which have happened to laborers in other industries have happened to automobile workers. It is dramatic license, of course, to hang a lot of scattered episodes on one place and time, but it will leave firm false impressions with a lot of people.

Labor has definitely turned to the theater as an educational and propaganda medium. In the play mentioned above a labor-sponsored enterprise comes "uptown." The results may be worth watching.

Parts Industry Reaches New Production, Employment Highs

The original equipment division of the parts manufacturing industry reached an all-time high in number of employes, factory rate, production hours worked and average of weekly earnings for the four-week period ending December, 1936, according to figures just released.

Average factory hourly rate is 72.1 cents per hour against 55.5 cents for December, 1933; 63.3 cents for December, 1934; and 66.6 cents for December, 1935. Male production employes earned 75.6 cents per hour and non-productive employes earned 82 cents per hour for this period.

The 48 companies used to make up the original equipment division reports employed a total of 85,328 factory workers during December as against 74,646 for December, 1935, and 65,405 which was the average figure for 1929. The production index represented by the number of man-hours worked went over 100 per cent for the first time since 1929 when it reached the high of 105.2 in December. Total payroll for the four-week period was more than $10,000,000—the highest on record.

Kelvinator Strike Ends, Wage Increase Granted

After four days of conferences, the 15-day sitdown strike at the Kelvinator plant of Nash-Kelvinator Corp. was settled, Feb. 16, with an agreement between company representatives and officials of the Mechanics Educational Society which sponsored the strike. The plant was evacuated by strikers late Tuesday afternoon.

Terms of settlement include wage increases of 5 to 7½ cents an hour for the company's 2500 workers; a minimum wage of 75 cents per hour for men, except in certain unskilled classes where men are to be hired at 65 cents an hour and raised automatically to the 70-cents minimum after 30 days; minimum wages of 60 to 65 cents for women, according to classification; immediate resumption of work; negotiation of all remaining differences between company and union in conferences to start within two weeks and be determined within 40 days. Wage increases became effective Feb. 18. The company also agreed there would be no discrimination against strikers or union members.

Seaman Body Adds Two Large Presses

The Seaman Body Corp., Milwaukee, wholly-owned subsidiary of Nash-Kelvinator Corp., is completing the installation of two large presses costing $150,000 which will step up its daily output of Nash enclosed car bodies to 600 whenever necessary. Current output is about 480 bodies a day. Two full shifts and a smaller early morning crew are being employed. Since Feb. 1 about 200 men have been added, bringing employment up to about 4100, the largest number at work since early in 1929.

Quick Settlement Reached In Briggs Sitdown Strike

Dissatisfaction with the wage increase announced during the past week by Briggs Manufacturing Co. prompted a brief sitdown strike Tuesday night in the assembly division of the company's Mack Avenue plant, employing 500 workers. About 200 employes in the trim and cushion divisions joined in sympathetic sitdowns. After some confusion and hurried negotiations between strike leaders and plant officials, the strike was settled.

The company would not disclose terms of settlement but strike leaders stated that workers in the assembly division had been promised a 40-hour week instead of 45; increase of 5 cents an hour in addition to the 5 cents already given; an extra 5 per cent for night shift workers; time and a half for overtime; and speed of assembly lines to remain substantially as at present. The agreement was reached at 4.45 a. m.

Frank K. Stoddard

Frank Kemper Stoddard, 73 years old, pioneer automobile manufacturer, died of pneumonia in Dayton, Ohio, Feb. 12. He was associated with his uncle, the late John W. Stoddard, in manufacturing the Dayton - Stoddard car until the firm went into receivership some 15 years ago.

GM-Union Bargain

(Continued from page 239)

tatives and a secretary, with personnel substitutions permitted.

The opening session was devoted to preliminaries and a general discussion, with some conversation on the subjects of discrimination and national machinery for ironing out of grievances. Both sides reported that conversations had been amicable and good faith evidenced.

Although the question of representation in GM plants was believed to have been disposed of in the strike agreement and no new demands for recognition as sole bargaining agency were expected, union leaders indicated they would continue to press this demand.

Questions of seniority and discrimination were taken up in Wednesday's sessions. It is understood the union favors a national five-man board for handling grievances, while the corporation is said to prefer the present set-up by which discrimination and grievance cases are handled by foremen in the plants and if necessary taken up through the organization to higher corporation officials.

In the matter of seniority, the union demands that there be no distinctions between workers with dependents and those without, or between skilled and unskilled workers, demanding that seniority be based solely on length of service after three months. The corporation holds that seniority should start after one year of employment and that men with dependents and skilled workers be in a separate classification.

Speed of conveyor lines was the next subject in line for discussion.

Production at Oldsmobile was resumed Thursday. Operations at the Lansing division of the Fisher Body Corp. were started Tuesday morning and by Wednesday night this plant

was operating at near-capacity with both day and night shifts.

With the flow of bodies from Fisher under way, the Oldsmobile production lines for both 6 and 8 cylinder cars moved again Thursday morning.

By next week, capacity production will be under way with more than 1000 cars being produced daily and over 12,000 workers on the Olds and Fisher payrolls.

Alfred T. Clausen, general manager of the Fisher plant, said men were returning to their jobs Tuesday morning and that by Wednesday night production was at capacity. He said material started coming in from Flint Monday morning and that the first completed bodies were delivered to the Olds plant Wednesday night.

Peak production for Oldsmobile was expected to be reached early next week with an output of approximately 1080 cars daily in the local plant and 120 per day on the Pacific Coast.

When the Lansing units of GM were closed due to the sitdown strike in Flint, Olds had the largest bank of unfilled orders in its history on hand. During the period when the Fisher plant was closed and it was impossible to operate the Olds assembly lines, nearly 4000 workers were kept on the job building up a large supply of materials which are now in readiness along the lines of production.

Pontiac Motors again is assembling and shipping cars. Although a few days are required to get going full speed, February will still be a good month. Production should reach a maximum before the end of the month and the March schedule will call for 30,000 cars, which will be the largest month in the company's history.

At no time during the strike has Pontiac been completely closed. Close to 4000 men have been on the payroll. As a result of the large stocks of parts built up since assembly and shipping stopped, Pontiac is in a position to turn out cars as fast as bodies are available. Changes have been made in the assembly lines which will increase the capacity of the plant.

More than 100,000 GM employes made idle by the strike have returned to work with total GM employment on Thursday estimated at 215,000. By the middle of the coming week employment was expected to be up to the normal of 235,000 workers for this time of year.

Final assembly of Buick motor cars was resumed during the past week and output is being stepped up daily with a goal of capacity output before the end of the month. At the same time, the car distribution system of the Buick division was thrown into high gear with view to speedy replenishment of depleted dealer stocks and fast delivery of unfilled retail orders now in dealers' hands.

Notwithstanding the stoppage of production on Jan. 1, Buick sales during the first month of 1937 were the highest on record and substantially exceeded those of the previous year.

Graham to Build Tractors

Sears, Roebuck to Have Domestic Sales Rights for New Streamlined Machine

The first of the tractors which Graham-Paige is to build for Sears, Roebuck, under a contract giving Sears sole rights to the domestic market, has been completed and shipped to a southern State for final tests with various types of farm equipment. Two more sample tractors are in process of construction. Although considered fully developed and in final form, the tractors will be given rigid tests under all kinds of working conditions, as is customary with a new product, before regular production is started.

Graham-Paige has adequate plant capacity to handle the new product. Floor space which has been used for storing finished cars will be converted into the tractor department. Tooling operations are under way and according to present plans the company should be well into its manufacturing program during the current year.

The complete unit will be built at the Graham plant. It will be powered with the largest Graham engine, but certain sub-assemblies, such as transmissions and rear axles, will be purchased on the outside. The tractor has a number of new features, one of which is streamlining. It is equipped with lights and starter, and rubber tires or lug wheels probably will be optional.

The Grahams have considerable experience with tractors, since Robert Graham operates one of the largest farms in Indiana and is said to have definite ideas on tractor performance and construction.

While details on the agreement with Sears, Roebuck are not available, it is understood that Graham retains the right to market the product anywhere outside the United States.

Capacity Output Near

(Continued from page 239)

far as can be determined, competitors benefited little from the GM production delay, although the full effect of depleted field stocks of GM cars has not yet been registered.

Leading competitors, however, have been well booked ahead since automobile show time and had planned to run just about as they are doing without the GM incident.

Dealers report a loosening up in buying interest and actual commitments since the ending of the strike. Widespread wage increases, it is believed, will contribute further toward stimulating demand.

Another factor likely to boost unfilled orders is the prospect of higher prices for automobiles. Both labor and material costs have risen higher than anticipated when prices were established on 1937 lines and there is a growing feeling in the trade that higher car prices are in the offing. According to competent observers, it remains only for one of the leaders to take the initiative and the entire industry unquestionably will follow.

The Packard Motor Car Co. shipped 10,418 cars in January compared with 4986 in the corresponding month last year. This month the company expects to ship about 13,000 cars compared with 4517 in February last year. In March and April Packard expects to be shipping cars at the rate of 15,000 a month. Production in 1936 represented a 54 per cent increase over 1935 and since the introduction of current models last September production has been running 87 per cent greater than in the corresponding period a year ago. Deliveries to customers of 120's from Sept. 1, 1936, to last Feb. 1 were 16,541 compared with 15,955 in the corresponding five months a year ago.

Sales of Studebaker passenger cars and trucks for the first 10 days of February were 2492 compared with 1407 in the corresponding year of 1936—an increase of 77 per cent. This brings sales for the year to date to 10,227—an increase of 37 per cent over a year ago. The year 1936 was 68 per cent over 1935.

Retail deliveries of Graham-Paige Motors Corp. from Oct. 1 to Jan. 31 totaled 4564 cars, an increase of 35 per cent over the 3364 delivered in the corresponding period a year ago.

Buick's retail deliveries during the first 10 days of February totaled 1791 compared with 1706 in the corresponding period last year. The company enters March with a bank of 60,000 unfilled orders on hand, the largest in its history, according to Harlow H. Curtice, president.

During January 13,602 Pontiacs were delivered. The best January prior to that was in 1928 when deliveries were 9680. In January of 1936 the deliveries were 8253.

Continental Diamond Fibre Shifts Executive Personnel

Important personnel changes have been made by the Continental Diamond Fibre Co., Newark, Del., as a result of the resignation of L. W. Tarr, formerly general manager. J. P. Wright, president of the company, has assumed the duties of general manager and named J. Frank Anderson as his assistant in charge of plant operation and maintenance. Mr. Anderson will continue as vice-president of the Haveg Corp., but will relinquish to I. N. Morrison the active management of the Haveg plant at Marshallton, Del. Robert Stewart has been appointed production manager and Dr. G. E. Landt, technical director.

Automotive Metal Markets

Steel Production Reaches Point Near Mills' Capacity; Prices Open on Second Quarter Business

By William Crawford Hirsch

Gradual resumption of shipments to General Motors plants has caused a reshuffling of orders now on steel mills' books, rather than a spectacular stepping up of their operating rate. Ingot output, according to the American Iron & Steel Institute is about 2 per cent higher than last week and is felt to be not very far from ceiling performance when the present disparity between finishing and primary capacity and all other factors are taken into consideration. Some of the business booked in the last few weeks was of the sort that entailed little obligation in the way of speedy delivery, shipments during the current quarter at mills' convenience being about all that buyers expect. Much of this could, therefore, be scheduled for deferred rolling and finishing, thus permitting the more urgent needs of others to be cared for.

With the threat of a strike in the steel industry hardly dispelled by voluntary wage increases, every possible effort to maintain maximum output between now and April 1 is certain to be made. Quite a little second quarter business has been booked, the price being left open for determination on a basis of whatever the market may be at the time of shipment; but leading producers have let their customers understand that they have no intention of instituting a general price advance unless entirely unforeseen conditions make this step unavoidable.

The possibility of trouble in the coal industry is one of the minor headaches of steel makers whose supplies are expected to be adequate for three months' needs by April 1. Further hardening of scrap prices, together with a continuance of flirtations with foreign buyers on the part of scrap dealers, has become a source of real worry to steel mill purchasing agents. Not since 1923 have scrap prices been as high as they are now, and compared with depression years, they have just about doubled.

Pig Iron—Better interest in pig iron offerings on the part of automotive foundries is expected to develop within the next few days. There is some talk of the possibility of higher ore prices. Usually Ford Motor Co.'s annual inquiry, put out about April 1, brings out the coming season's ore price.

Aluminum—Steady amid routine conditions in both the primary and secondary branches of the market.

Copper—The price of electrolytic copper was raised on Tuesday a full cent to 14 cents a pound. Prices for copper and brass products were immediately revised upwards to conform to the higher level for the basic metal. Rise in the export price to very close to 14 cents and a 12 per cent reduction in refined copper stocks were pointed to as justification for the rise. It was a'so said in producers' circles that the rise was necessary to prevent diversion of copper, needed here, to European arms makers. Resumption of more normal automotive consumption, now that the General Motors strike is over, was, however, the most potent factor in the rise, the "bulls" on the London Metal Exchange having been temporarily frightened from their position by the strike.

Tin—Following a slightly lower opening on Monday, the market for spot Straits tin recovered on Tuesday to 51⅝ cents.

Lead—Quiet and steady.

Zinc—Firm.

Industrial Advertisers Assoc. Meets in Chicago Sept. 23-25

The 1937 conference of the National Industrial Advertisers Association will be held Sept. 23-25 at the Edgewater Beach Hotel, Chicago, according to an announcement by William E. McFee, president of the association.

Hupp Meeting March 4

A meeting of the Hupp Motor Corp. stockholders to discuss a refinancing program, postponed to Feb. 11 because of lack of a quorum, was again set back to March 4 for the same reason.

The C. J. Tagliabue Mfg. Co., Brooklyn, N. Y., has issued a new catalog on **laboratory thermometers and hydrometers.** Much useful information is contained in this publication, including comparison of scale graduations, corrections for emergent stems, instructions for using hydrometers, and fahrenheit and centigrade conversion tables.*

A booklet entitled **"Accessories for Monarch Lathes"** has been brought out by the Monarch Machine Tool Co., Sidney, Ohio.*

A new catalog has been issued by the Gisholt Machine Co., Madison, Wis. The publication contains information on standard **chucking tools, bar tools** and **cross-slide tools,** as well as chucks, boring bars and reamers, and machine attachments.*

"Heat Transfer Surfaces for Air Conditioning and Commercial Applications" is the title of the latest publication issued by the Young Radiator Co., Racine, Wis. Another bulletin recently brought out by this company describes the Young jacket water coolers for gasoline or Diesel engines.*

*Obtainable from the Editorial Department of AUTOMOTIVE INDUSTRIES. Address: Chestnut & 56th Sts., Philadelphia, Pa.

Calendar of Coming Events

SHOWS

Automobile Show, Berlin, Germany, Feb. 20-March 7
Hungary, International Automobile, Motorcycle and Motor boat Exposition, Budapest .....March
France, Automobile Section, Lyons Fair, Lyons .....March 4-14
France, Automobile Section, Com'l. and Industrial Fair, Lille .....March 3-18
Austria, Automobile and Motorcycle Salon, Vienna .....March 7-13
Holland, Automobile Section, Royal Netherlands Fair, Utrecht ..March 9-18
Switzerland, 14th International Exposition, Automobiles, Motorcycles and Bicycles, Geneva .....March 12-21
Algiers Fair, Automobile Section, Algiers .....March 20-April 4
Portugal, 11th Automobile Salon, Porto March 27-April 5
Yugoslavia, 14th Automobile Salon, Zagreb .....April 17-26
Illinois Automotive Ass'n, 4th Annual Show and Maintenance Exhibit, Navy Pier, Chicago .....Apr. 24-28
Poland, Automobile Salon—16th International Fair, Poznan .....May 1-10
Norway, Automobile Salon—Oslo..May 7-10
Second Annual Automotive Maintenance Show, San Francisco..May 20-23
Morocco, Automobile Section, Tangier Fair, Tangier .....June
France, Automobile Section, Bordeaux Fair, Bordeaux .....June 13-28
Belgium, First International Aeronautical Salon, Brussels ....June 18-30
Fourth ASTM Exhibit of Testing Apparatus and Related Equipment, New York .....June 28-July 2
Poland, Automobile Salon (Foire Orientale), Lwow .....Sept. 1-15
France, 31st International Automobile Salon, Paris .....Oct. 7-17
Great Britain, 31st International Automobile Exposition, London..Oct. 14-23
National Automobile Show, New York, Oct. 27-Nov. 3
Italy, 10th International Automobile Salon, Mi'an .....Oct. 28-Nov. 8
Great Britain, 13th International Commercial Automobile Exposition (trucks and buses), London..Nov. 4-13
Chicago Automobile Show.....Nov. 6-13
Great Britain, 36th Scottish International Automobile Exposition, Glasgow .....Nov. 12-20

CONVENTIONS AND MEETINGS

Association of Highway Officials of No. Atlantic States, 13th Annual Convention, New York .....Feb. 24-26
American Society for Testing Materials, 1937 Regional Meeting and Committee Week, Palmer House, Chicago, March 1-5
Sixth Annual Welding Conference and Exposition, Ohio State University, Columbus, Ohio .....March 3-5
S.A.E. National Aeronautical Meeting, Washington, D. C. .....March 11-12
Export Managers Club, 20th Anniversary Get-Together, Hotel Pennsylvania, New York .....March 30
S.A.E. Regional Transportation and Maintenance Public Utility Meeting, Baltimore, Md. .....April 15-16
International Association for Testing Materials, Second International Congress, London, England..April 19-24
S.A.E. National Tractor and Industrial Power Meeting, Peoria, Ill..April 21-23
41st Annual Convention and Exposition of the American Foundrymen's Association, Milwaukee .....May 3-7
S.A.E. Summer Meeting, White Sulphur Springs, W. Va. .....May 4-9
American Society of Mechanical Engineers, spring convention, Detroit, May 17-21
American Petroleum Institute, Mid-Year Meeting, Colorado Springs, Colo. .....June 1-3
Second World Petroleum Congress, Paris, France ....late May—early June
Automotive Engine Rebuilders Association, 15th Annual Convention, Chicago .....June 21-24
American Society for Testing Materials, 40th Annual Meeting, New York, June 28-July 2
S.A.E. National Aircraft Production Meeting, Los Angeles, Calif....Oct. 7-9
S.A.E. Annual Dinner, Commodore Hotel, New York .....Oct. 28

CONTESTS

Indianapolis Speedway, 500-Mile International Sweepstakes .....May 31
Pan American Cup Race, Roosevelt Raceway .....July 5
Roosevelt Raceway, 400-Mile George Vanderbilt Cup Sweepstakes....Sept. 6
Los Angeles, 500-Mile International Sweepstakes .....Nov. 28

Just Among Ourselves

What About the Price Level?

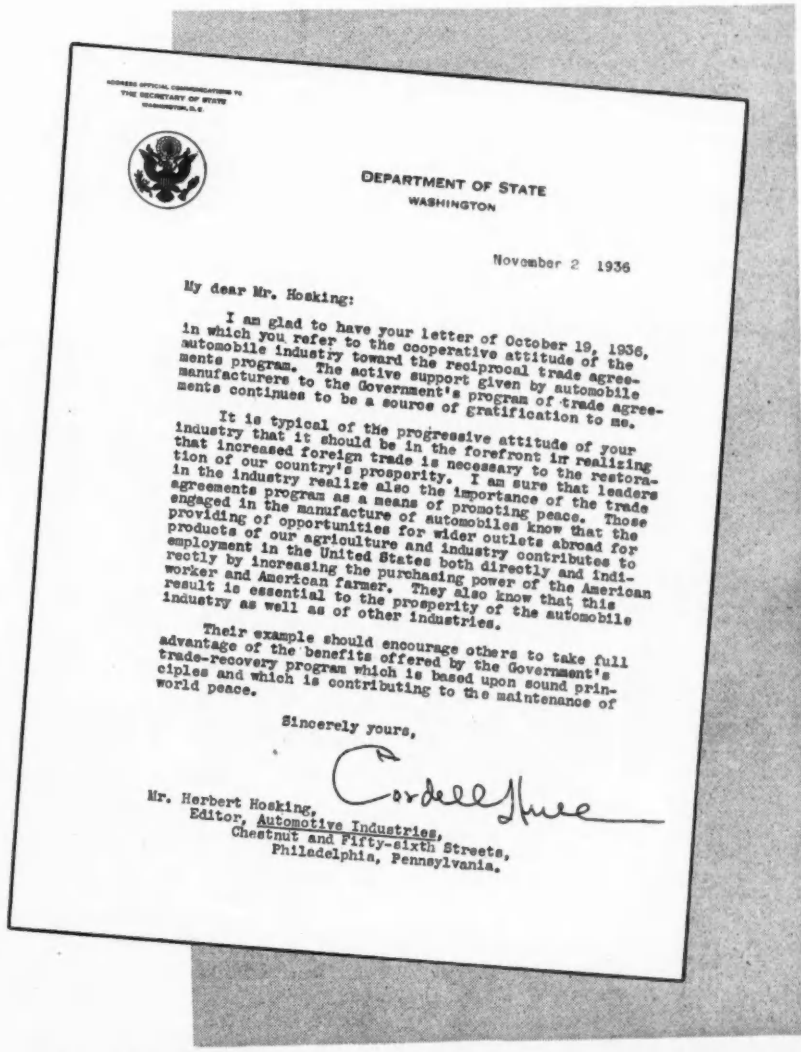
NEGOTIATIONS between General Motors and the United Automobile Workers, which began Tuesday the 16th, are in a preliminary stage, which will probably develop little headline material. Principals on both sides will take a short respite while some of the groundwork is established and the way prepared for the discussion of essentials. What are the portents of the lull? Wage advances by Chrysler, General Motors and Packard have increased the cost of manufacturing automobiles. Necessary price concessions to automotive suppliers have added to the cost of component parts. Price advances on automobiles are being hinted at by some factories. And, so far as we can see, it will be a miracle if they don't come about. There has been considerable delay in the general announcement of "delivered in Detroit" prices by some automobile manufacturers. We believe this condition may have arisen from a natural reluctance to announce a price schedule which would have to be upped shortly after the original announcement. Such a condition might destroy some of the benefit of the delivered-price arrangement.

All Agreed On Reciprocal Tariffs

LAST October we sounded out Secretary of State Hull on the question of reciprocal trade treaties and the automobile industry. The letter which appears at the bottom of this page was his reply. We mention it now because the House of Representatives passed, on Feb. 9, a resolution continuing in effect the power of the Secretary of State to negotiate reciprocal trade treaties with foreign nations. On Feb. 11 and 12 the Senate Finance Committee conducted hearings on the resolution, at which appeared Robert Graham, vice-president of Graham-Paige, on behalf of the Automobile Manufacturers' Association and of continuance of the bill. In spite of unsettled conditions abroad, export business in 1936 was extremely satisfactory to most export men, and they are, on the whole, willing to give considerable credit for it to the careful and consistent application of reciprocal trade principles by the Department of State. No industry has ever taken a broader view of its own interests and those of the nation than the automobile industry in its advocacy of reciprocal trade agreements. We subscribe firmly to the view that it is important for the industry and the nation that the power to draft such agreements should be continued.

It's Necessary

THE word espionage, like propaganda, carries malign connotations not necessarily inherent in it. It is difficult for us to see how large corporations can operate without using it in some form. For the better side of the question (your daily newspaper will furnish plenty of data on the worst), see our remarks in AUTOMOTIVE INDUSTRIES for May 9, 1936.—H. H.



ADDRESS OFFICIAL COMMUNICATIONS TO THE SECRETARY OF STATE WASHINGTON, D.C.

DEPARTMENT OF STATE
WASHINGTON

November 2 1936

My dear Mr. Hosking:

I am glad to have your letter of October 19, 1936, in which you refer to the cooperative attitude of the automobile industry toward the reciprocal trade agreements program. The active support given by automobile manufacturers to the Government's program of trade agreements continues to be a source of gratification to me.

It is typical of the progressive attitude of your industry that it should be in the forefront in realizing that increased foreign trade is necessary to the restoration of our country's prosperity. I am sure that leaders in the industry realize also the importance of the trade agreements program as a means of promoting peace. Those engaged in the manufacture of automobiles know that the providing of opportunities for wider outlets abroad for products of our agriculture and industry contributes to employment in the United States both directly and indirectly by increasing the purchasing power of the American worker and American farmer. They also know that this result is essential to the prosperity of the automobile industry as well as of other industries.

Their example should encourage others to take full advantage of the benefits offered by the Government's trade-recovery program which is based upon sound principles and which is contributing to the maintenance of world peace.

Sincerely yours,

Cordell Hull

Mr. Herbert Hosking,
Editor, Automotive Industries,
Chestnut and Fifty-sixth Streets,
Philadelphia, Pennsylvania.

Ethyl Fits the Job —

That is the duty of a staff of engineers who test, instruct, and service engine builders and operators. Cooperation is carried to such a degree that the answer to every new need or design has been anticipated.

THE familiar word "Ethyl" is so intimately related to things automotive, ranging from the laboratory to the cross-roads service station, that we may reasonably assume that technical men, at least, are well acquainted with the rich literature which had its inception with Thomas Midgley's pioneer researches in the field of detonation and knock-suppressing compounds.

Today, after the acid test of the years, tetra-ethyl lead still remains as the most economical commercial treatment for gasolines which are used in the modern high-performance engine.

In Detroit, the Ethyl Gasoline Corporation maintains one of the finest and most modernly-equipped research laboratories in the industry for the purpose of fundamental and commercial investigation. Yet we doubt whether even the best informed technical men have a good idea of the amazing ramifications of its activity. Despite our own close contact with the organization, we found during the course of a recent visit that this organization's activity encompasses a breadth and variety far beyond anything we have ever conceived.

Our object in this article is to give a very brief picture of those things that would be of greatest interest to automotive engineers.

Perhaps the best approach to this end is to outline very briefly a few of the basic types of investigation which are a part of the every-day Ethyl program. Accordingly, let us examine the following:

1. Fuel testing is easily of major importance. This program follows current engine design trends and aims to anticipate future requirements so that as and when new engine developments occur, the most efficient type of fuel will be available.

2. The second major activity is on special projects in cooperation with engine builders in every branch of the industry—aircraft, passenger cars, trucks, buses, marine, tractor and industrial engines. This includes such studies as high-compression developments, valve design, manifold improve-

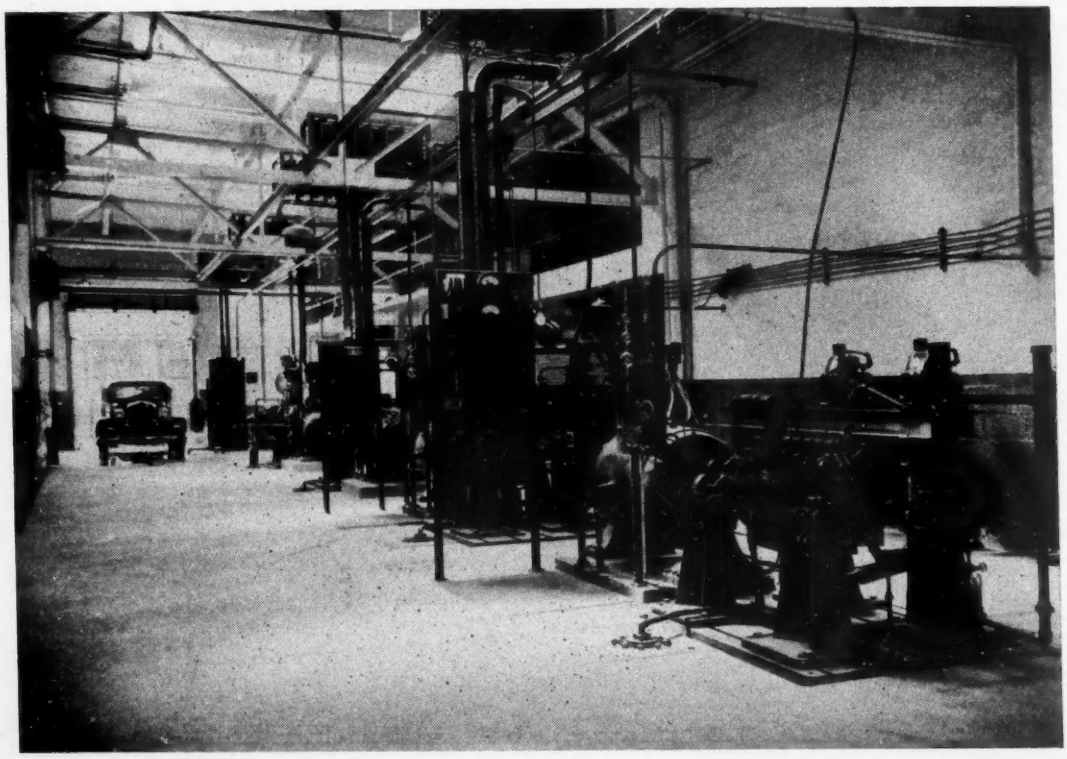


Fig. 1. General view in dynamometer department at Detroit which is equipped with 13 electric dynamometers ranging in capacity for 15 to 300 hp.

By Joseph Geschelin

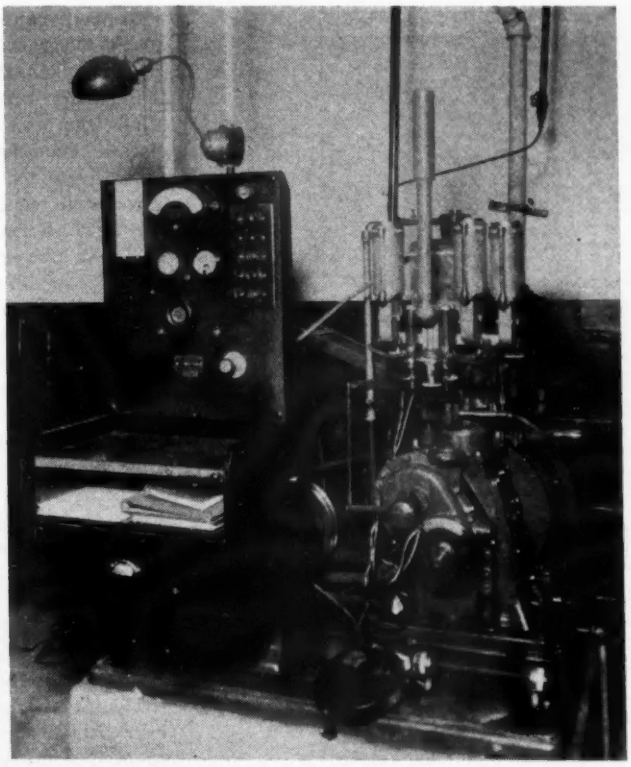
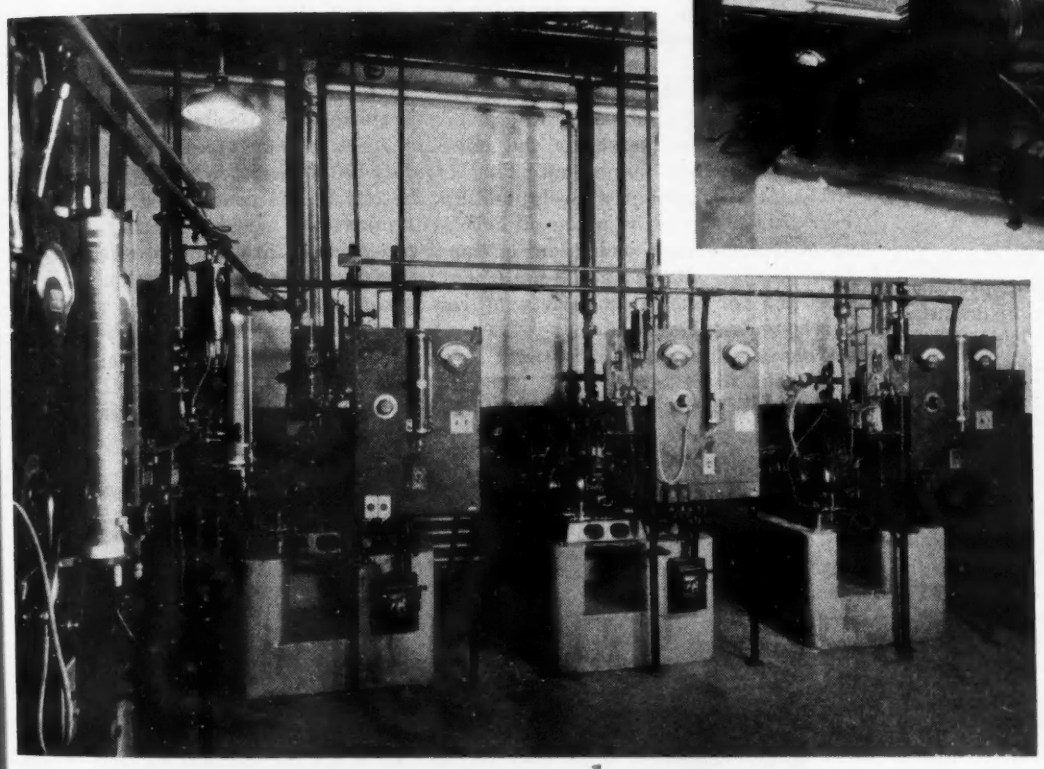


Fig. 3 (Above) A standard variable-compression test engine is used for rating anti-knock value of motor car fuels

Fig. 2. (Below) Single cylinder engines offer many advantages in some types of research work, and the laboratory at Detroit has a number of standard units set-up as shown here



ment, combustion chamber forms, spark, plugs, etc.

3. Service problems, that is, the problems that originate in the field constitute a third major activity. Such problems, including the endless variety of questions usually associated with fuel are tackled as they come up, and quite naturally are not considered as a part of the organized routine of the organization. However, the testing of fuel samples from the field and from licensees, although it may be considered under this heading, is a regular and routine procedure.

4. An interesting by-product of the fundamental and commercial research program is the development of a comprehensive procedure manual used by Ethyl technicians. Its objective is to define as completely as feasible, the procedures for a variety of laboratory and field tests so as to assure the accumulation of all pertinent data. This manual is steadily growing in scope and completeness and constitutes, even in its present form, an invaluable contribution to engineering techniques.

Personnel

The brief perspective pictured above leads us directly to what may be termed the modus operandi of the organization—through its personnel set-up. For this purpose we may consider the organization as being composed of two distinct groups—the technical executives and laboratory staff; and the sales or contact men in the field.

The first group, with automotive and physical research under the direction of Earl Bartholomew, and chemical work under George Calingaert, forms the backbone of all fundamental and commercial research comprehending all formal laboratory testing, automotive, chemical, and physical.

The second group also operates under the research department, and is headed by J. J. Frey, head of the Contact Division. The men in this group are specialists who are in constant contact with the field and with the primary producers in various fields, such as petroleum refiners, automotive manufacturers, agricultural and industrial tractors, etc. In addition to making

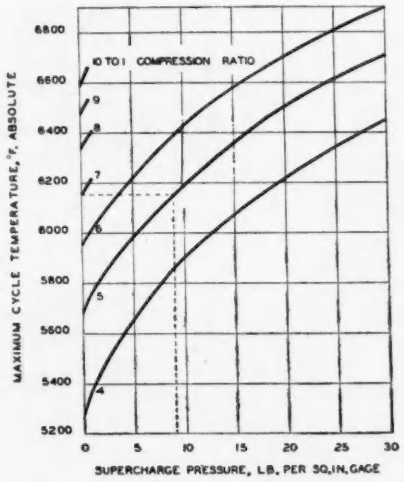


Fig. 4. Example of the ideal Otto cycle charts developed on basis of theoretical calculations. This one indicates range of maximum temperatures in accordance with variations in compression ratio and degree of supercharge

systematic calls, the contact men are subject to call whenever special or immediate problems occur in manufacturing plants and in the field.

It is obvious that this set-up makes for an intimate and sympathetic knowledge of the entire field and makes the whole organization unusually well-informed as to current and future developments.

Equipment

Now for just a brief comment on the facilities that the organization affords.

The building housing the principal research laboratories is located at Detroit. In the dynamometer department, Fig. 1, thirteen electric dynamometers ranging in capacity from 15 to 300 horsepower, in some cases arranged for the connection of engines to either end, accommodate a full range of engines from the single-cylinder type to the largest multi-cylinder passenger car, truck and bus engines. Engines of 325 horsepower can be run at 6000 rpm. Six dynamometers, located in a single large room where they may be controlled by a single attendant, are used for all kinds of endurance running. One valve steel is compared with another, or one type of spark plug construction with another, and fuels of various types are rated in terms of the performance of a standard fuel. Such endurance tests are run for 50 to 500 hours.

Automatic controls provide for the maintenance of cooling water temperature at any desired figure, and other controls vary the load applied and its period of application in accordance with pre-arranged schedules. Neon tube spark protractors, attached to the engine crankshaft, continuously indicate the ignition timing. Oil, water, air and other temperatures are indicated by distant reading thermometers on the control panels. Records are kept of barometric pressure and of wet and dry bulb thermometer readings in order that power readings may be corrected to a definite standard.

Air consumption is determined by specially designed and calibrated round-edge orifices screwed into surge tanks which are located as close as possible to carburetors for the elimination of resonance effects. Graduated glass bulbs of several capacities, located on the control panels, permit the rapid check from time to time of the constancy of carburetor metering characteristics.

A number of the dynamometers are located in separate rooms where research is not hampered by the noise of the endurance test room. This is particularly important where audibility observations are to be made of knocking tendency. Each such room is complete with controls and equipment necessary for the wide variety of research undertaken.

A chassis dynamometer permits cars and trucks to be tested in the laboratory at full load under conditions which simulate actual road operation. Vehicles to be tested are chained in place with their rear wheels rotating on large paper pulleys mounted on a shaft which, through a silent chain drive, turns a regular engine dynamometer.

Other laboratories make endurance tests on single cylinder engines, Fig. 2. In some cases the single cylinder engine not only offers the advantage of lower operation cost, but permits the divorce of the variable under test from certain inherent characteristics of multi-cylinder engines, such as inequalities of mixture distribution, volumetric efficiency and cooling. As in the case of the dynamometer engines, provision is made for the easy determination of air and fuel flowing to each engine. Power is indicated by watt-hour meters and ignition timing by neon tube protractors mounted on the crankshafts. Cooling liquid temperatures are maintained constant by reflux condensers which condense and return to the system the vapor of the liquid used, which may be any liquid having a boiling point up to 400 deg. F.

A standard variable compression engine, Fig. 3, is used for rating the anti-knock value of motor car fuels, while a somewhat similar unit is available for rating aviation fuels. Because of the high brake mean effective pres-

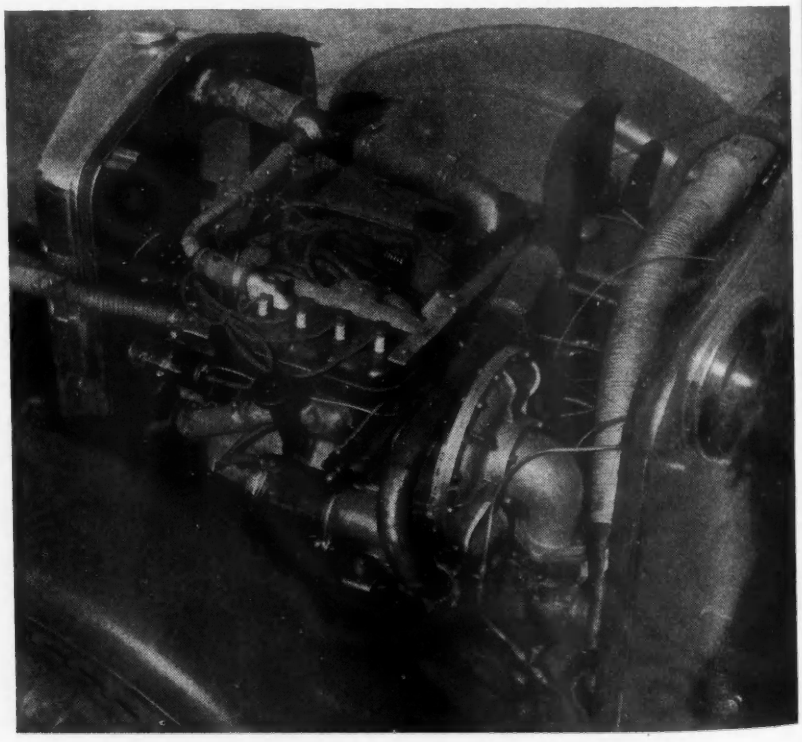


Fig. 5. In field testing of supercharger installation, the supercharger was driven independently by an Austin engine. The unit is seen mounted under the hood with the supercharged mixture carried over by piping from the left side to the intake manifold on the right

sure at which aviation engines usually operate, the anti-knock stability of fuels is given a much more severe test and correspondingly more severe laboratory tests are required for proper correlation with actual service. The Army Air Corps uses a jacket temperature of 375 deg. Fahr., and other unusually severe laboratory engine conditions. The requirements of some of the more recent engines indicate the necessity for even more severe engine conditions.

A branch engineering laboratory has been established at San Bernardino, California, where, within easy driving distance, are to be found a variety of topography and climatic conditions probably not excelled in this country. Good roads are available at elevations of from 200 feet below to 7,000 feet above sea level. On one road the elevation changes almost 6,000 feet in 35 miles, 12 per cent grades occurring at some points. The Muroc Dry Lake on the Mojave Desert has a length of 12 miles and, because of its remarkable flatness and smoothness, permits indefinitely sustained speeds as high as engines are capable of producing.

In addition Ethyl maintains a fleet of test cars and trucks at Detroit. In the road test department are facilities for the storage, repair, washing, greasing and adjustment of test vehicles. Each new test requires an overhauling and adjustment of the test vehicle by the best equipment available. Facilities for the storage and blending of gasoline are similar to those in the dynamometer department.

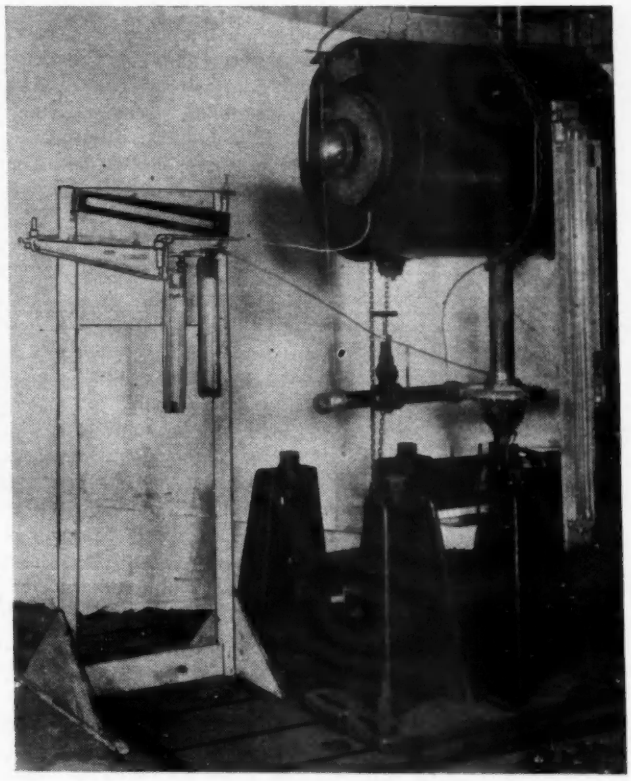


Fig. 6. Rating supercharger characteristics at the Detroit laboratories was done in the set-up shown here. The surge tank for measuring intake air is shown above the supercharger which is mechanically driven below

Examples of Research Program

The foregoing gives a generalized picture of the research organization and its work. How it actually functions may be more readily appreciated by studying several specific projects which are of wide, current interest.

Let us consider supercharging. Over a brief period of years the cooperative work of engine designers and petroleum technologists has resulted in the development of high performance engines capable of higher speeds, greater flexibility, improved fuel economy, and an extraordinary high value for power developed per cubic inch of displacement. On passenger cars, this has made possible a steady increase in power to engine weight ratio; on trucks, it has halted the alarming increase in engine size due to the demand for greater power capacity.

To many it has seemed desirable to investigate the virtues of supercharging as a possible means of providing increased performance and efficiency without further increasing engine size and weight. And Ethyl already has done much work along this line both on passenger car and truck engines.

Now a basic problem of any research organization is to arrive at a rational correlation between laboratory results and actual field applications, for it is frequently a far cry from the dynamometer to the truck in the hand of an operator. That is the basis for most of the work here, and its full development may be gaged from this example.

The first step in the investigation of supercharging was to set up the ideal or theoretical boundaries of the problem. Since both increased compression ratio and supercharging increase the temperature of the last portion of the charge to be burned, and therefore promote detonation, a thermodynamic analysis is desirable to determine the economics of the situation.

A series of ideal indicator cards were therefore calculated and plotted. Displacement is 100 cubic inches in all cases (exclusive of supercharger), atmospheric pressure and temperature 14.7 lb. per square inch and 68 deg. Fahr. respectively, exponent of compression 1.4, gas constant 43.34, calorific value of charge 1000 B.t.u. per lb., and specific heat at constant volume 0.0171. It was realized, of course, that in actual engines the pressures and temperatures attained are considerably lower than the calculated values because of wire-drawing of the charge, heat loss to cylinder surfaces, and decomposition of water and carbon dioxide at high temperatures. However, these differences are not important in a relative comparison of cycles.

Fig. 4 shows the maximum temperature of ideal Otto cycles from 4 up to 10 to 1 compression ratio unsupercharged and of cycles of 4, 5, and 6 to 1 ratio supercharged up to 30 lb. gage. At 7 to 1 compression ratio without supercharge the maximum cycle temperature is 6160 deg. Fahr. absolute, and at 5 to 1 ratio the same temperature is reached at 8.9 gage supercharge. It would be expected therefore that engines operating under these conditions would require fuel of approximately the same octane number.

It was found that the economy of the 5 to 1 supercharged engine is better than that of the 7 to 1 unsupercharged engine only at less than 63 per cent of full output, and then only by a small margin. Keeping in mind the fact that the small 5 to 1 supercharged engine has the same fuel octance requirements as the 7 to 1 engine unsupercharged, it becomes obvious that supercharging is not in general a means to higher economy.

Without going into all the details of the ideal cycle, we may say that the next step is to compare the results of dynamometer tests with the theoretical concept. This work is now in progress on passenger car engines.

For motor trucks, the situation developed in reverse order. Due to the

heavy-duty truck train operations on the West Coast, there has been an increasing need for improved high-gear performance due to the extremely heavy grades, some of which range from 6000 ft. elevation.

Accordingly, Ethyl's California organization undertook a study of heavy-duty operations of this nature to determine whether supercharging would offer a solution. It was realized by these men that supercharging requires more power than is appreciated and, consequently, they decided to drive the supercharger independently by means of an auxiliary engine, thus making the net power of the main engine available for lugging. The advantages of this arrangement are obvious—it permits the use of the most economical size main engine, thus improving its fuel economy; it permits flexible operation of the supercharger, cutting it in only as required and thus holding to a minimum the fuel consumption of the auxiliary.

On this test the supercharger was driven by an Austin engine, four-cylinder, 2.2 in. bore x 3 in. stroke, 45.5 cu. in., rated 13 hp. at 3200 r.p.m. This unit was mounted under the hood of the main engine as shown in Fig. 5. Independent operating controls as well as a separate fuel tank were provided.

At the time of this writing, the service tests had not been completely organized so that no direct comparison is available on the basis of relative fuel economy.

While this road test was in progress, the Detroit laboratory took a hand in the situation and started a parallel study on the supercharger unit. To this end a series of laboratory tests were run with the set-up shown in Fig. 6. The net result of the test work was to establish definitely the delivery of the supercharger, its efficiency, best operating speed, and net horsepower required to drive it at maximum output.

These results immediately proved that the supercharger set-up in California was not operating at maximum output and consequently was not providing the engine with its maximum benefit. We may see, therefore, how this program of correlating road testing with the laboratory, provided an immediate check on the field work and brought out limitations which could not be obvious in the field.

Armed with this new and specific information, it will be possible to improve the supercharger installation and schedule some field tests which are bound to produce more conclusive results.

Commercial Development

In an effort to make a definite engineering contribution along the line of improved performance in general, Ethyl has started a new commercial testing project in actual field service on the West Coast. For this purpose they have purchased a fleet of motor trucks, comprising three well-known makes in four different models, including tractor-semi-trailers and truck trailer trains. In addition, they have in operation a fleet of 1937 passenger cars comprising representative samples of popular makes and models.

The field work is paralleled by dynamometer testing which at first is based upon customary laboratory procedure and then is modified to approach service conditions as these relations develop from the field work. Fig. 7 shows a 1936 Chevrolet engine on the dynamometer, fitted with automatic controls for varying load and speed, in an effort to simulate service conditions.

In the case of trucks and passenger cars, the principal objective is to determine the influence of high-compression upon fuel economy, discover the best engine conditions for maximum fuel economy, and to investigate various fuels. On passenger cars, they have developed a special form of carburetor which permits the simultaneous use of two different types of fuels, fed to separate banks of cylinders by means of the current types of divided induction systems.

For truck testing, they fit two separate carburetors, carefully synchronized as to throttle position and throttle opening. Fig. 8 shows a typical installation of this type.

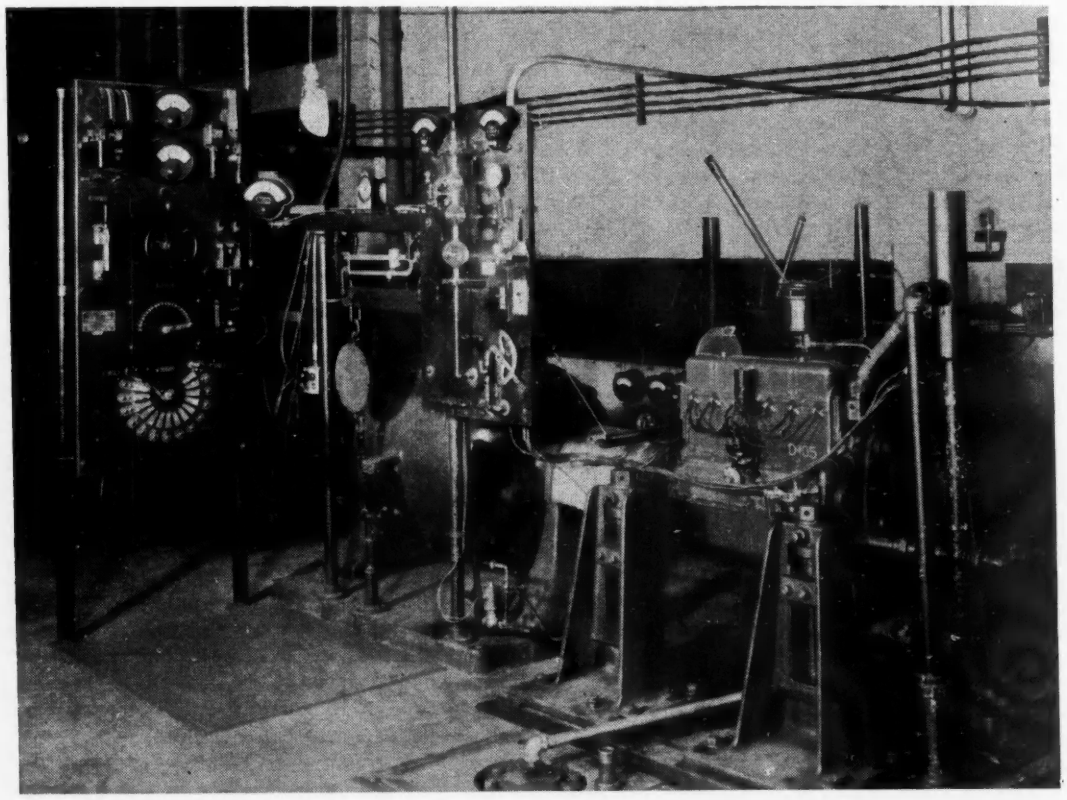


Fig. 7. This 1936 Chevrolet engine shows how dynamometer set-up is modified so as to simulate actual operating conditions. The engine is fitted with controls which automatically vary speed and load

With this arrangement it has been possible to eliminate the judgment factors and usual variations due to the attempts at running separate tests on the effects of different fuels in the same engine. It eliminates the errors due to repeated tests where an effort is made to simulate the exact conditions of engine and atmosphere for both tests.

It is now possible not only to use two different fuels simultaneously and thus note effects on engine condition and performance, but also to make simultaneous tests with varying fuel-air ratios.

Another project along the same line is being carried on in the tractor and industrial field. The objective here is to rate the performance of engines when running on different grades of gasoline and the available grades of distillate. An effort is being made to find the most economical type of fuel which will produce the best results on this type of powerplant.

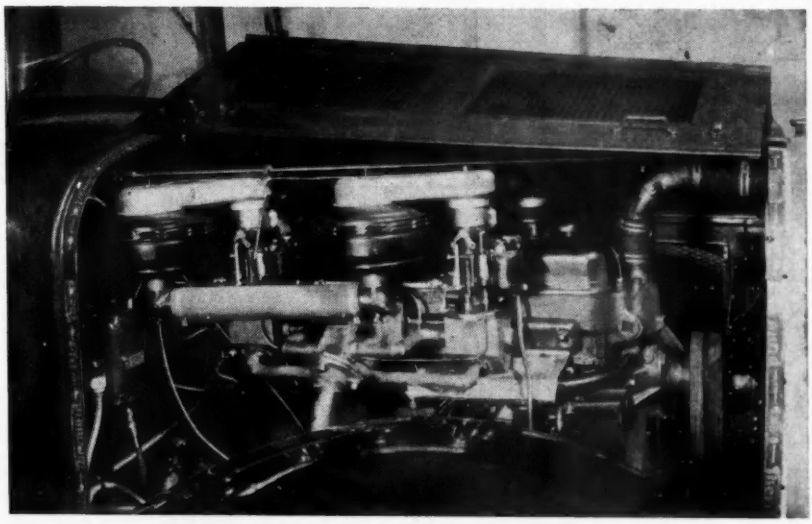


Fig. 8. For truck tests, the engine is fitted with two separate carburetors carefully synchronized as to throttle position and throttle opening. This permits the simultaneous testing of different fuels, varying air-fuel ratios, etc.

Future Development

The best summary of the work and outlook of this organization may be found in the program of future investigation and development which has been laid down as a definite policy.

The development of automobile engines has progressed far but the opportunity for further improvement is even greater. At a fuel consumption of 1.5 lb. per brake-hp.-hr., which is about an average for conditions of slow speed driving, an engine converts less than 10 per cent of the calorific value of the fuel into power. At wide-open throttle with the mixture for best economy, a condition rarely approached in service, the thermal efficiency is only about 25 per cent.

The maximum brake mean effective pressure of automobile engines does not much exceed 100 lb. per sq. in. The Army Air Corps has obtained a b.m.e.p. of 579 lb. (without deduction for power required to drive the supercharger) at a fuel consumption of 0.506 lb. per b.hp. per hr. on an experimental single cylinder. The anti-knock value of the fuel, which imposed the limit on the output obtainable, was considerably below the maximum of fuels now available in limited quantity.

The powerplant still occupies much of the chassis length in cars today. An increase in brake mean effective pressure, resulting in the development of the same or more power by a smaller engine, would create new possibilities in car design and perhaps reduce gasoline consumption. There are four means available for accomplishing this result, viz.:

1. Drastic changes in the design of engines for the purpose of securing better cooling.
2. An increase in compression ratio and the use of fuels of higher anti-knock value.
3. Supercharging.
4. A combination of two or more of the above design features.

It is doubtful whether the block type cylinder can ever be made to cool as well as separate cylinders but it seems equally impossible to cheapen the latter type of construction until it approaches the cost of cylinder blocks made in the foundry. There is the possibility of internally cooled pistons and exhaust valves and other modifications for the elimination of hot spots and reduction of average cylinder temperature but it appears that only extreme necessity will compel the abandonment of the cast cylinder block which has been the principal factor in bringing the cost of engines down to the present level.

Improved cooling would increase the volumetric efficiency and the permissible compression ratio on fuels now available and would probably be essential to a satisfactory realization of the potential contribution of supercharging and increased compression ratio in conjunction with better fuels.

Chicago Truckers Organize

Organization of National Freightways System, an alliance of motor trucking companies along plans similar to the National Trailways System that was formed among leading independent bus operators last summer, was announced in Chicago this week. Fourteen trucking organizations are said to be members of the association at the present time.

The alliance of bus operators had for its backbone several of the leading railroad-owned lines, and while there are no railroad-owned truck lines affiliated with the new association at the present time, plans are being made to allot memberships to some.

R. H. McCoid, well known in Chicago trucking circles, is the organizer and is serving as president of the association. He was for three years manager of the Consolidated Motor Freight Terminal in Chicago. Advantages of the organization to the independent operator, as they are outlined by Mr. McCoid are: added confidence of shippers in dealing with a large organization, interchange of freight through a single terminal, systematic pickup and delivery, interchange of freight at principal points and saving in handling costs.

Members of the association will retain their individual identities, file their own tariffs and rates, solicit their own business and in every other way conduct themselves independently.

Engine Development M

By P. M. Heldt*

IF the present trend toward lower overall heights of cars continues, it will become necessary before long to do away with the central longitudinal propeller shaft, which now places a limit on the minimum floor height. We can then go to either front-mounted engines with front drive or rear-mounted engines with rear drive. In both cases the powerplant is located at the same end as the driving wheels, and the long propeller shaft is dispensed with, which, incidentally, eliminates problems due to the tendency of these shafts to whip at high speeds.

Each type of construction imposes certain requirements with respect to the powerplant, and it was at least partly due to the non-availability of engines really adapted for front-wheel drive that this type of car did not go over so well when it was first introduced here some eight years ago. One very important requirement in any four-wheeled vehicle with two-wheel drive is that there shall be plenty of weight on the driving wheels, to assure adequate traction even under unfavorable conditions. In a rear-drive vehicle this is readily obtained, because not only can the car be made to overhang the rear axle considerably, but conditions which call for abnormal traction, and therefore for more than normal adhesion between tire and pavement, transfer weight from the front to the rear wheels. More traction is required when the car ascends a grade, and a larger percentage of the total weight then rests on the rear wheels. Besides, the driving torque tends to lift the front of the car, thereby reducing the pressure of the front wheels on the pavement and simultaneously increasing the road pressure of the rear wheels. As both

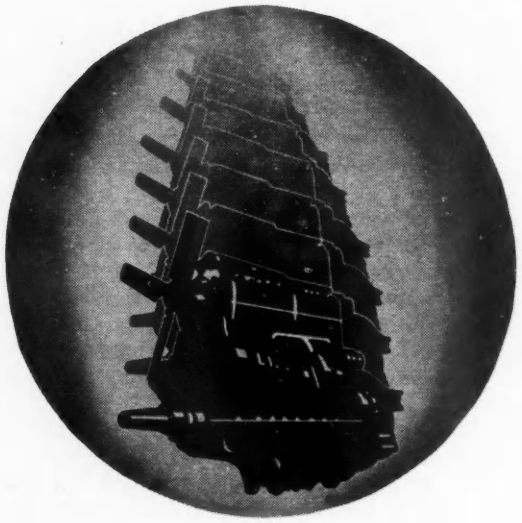
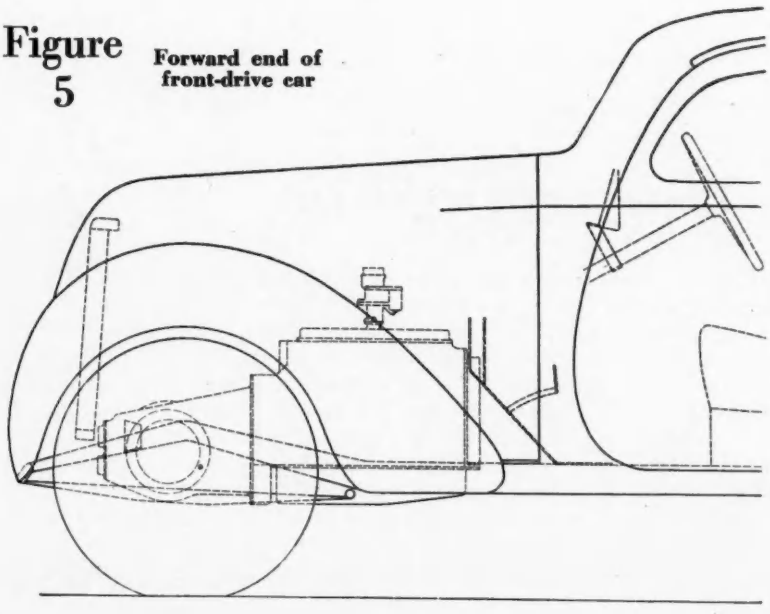


Figure 5 Forward end of front-drive car



of these conditions remove weight from the front wheels, they affect front-wheel traction adversely, and the situation can be met only by so designing the car that a large proportion of the total weight rests on the front wheels in the first place. A short, compact powerplant is of help in achieving this end. Fig. 5 shows the front end of a front-wheel-drive car designed by R. C. Hoffman. It can be readily seen that if the engine were of a long type, say, an eight-in-line, its center of gravity would of necessity be further removed from the front axle, and a smaller proportion of its weight would be carried on the front (driving) wheels.

In the rear-engined car, also, certain

*Presented as a paper at the Annual S.A.E. Meeting in Detroit.

Moves Forward—

In this part the various types of engine that lend themselves particularly to installation in front-drive and rear-engined cars are discussed from the standpoints of their torque and mechanical-balance characteristics. V-type, narrow-V, horizontal opposed and radial engines are analyzed with respect to torque uniformity and balance of reciprocating parts.

Part Two

Part one of this paper appeared on page 146 of the January 30, 1937, issue of AUTOMOTIVE INDUSTRIES

requirements of weight distribution must be met. It is practically impossible to place a conventional in-line engine back of the axle in a fore-and-aft direction, as that leaves too little weight on the front axle. Here, again, weight is transferred to the rear wheels by an up grade and by the driving torque, and, of course, enough weight must remain on the front wheels even under the most adverse conditions to assure dependable steering. Another objection to an engine placed too far back is that it reduces the aerodynamic stability of the car. To ensure such stability, the center of gravity must be located ahead of the center of pressure, and this requirement is hard to meet with a car having the powerplant behind the rear axle, except by providing it with a large tail fin, which is certainly not a desirable feature of a car designed for use on congested roads. It may be recalled in this connection that Daimler-Benz in 1934 brought out a rear engined car with a four-cylinder engine mounted longitudinally back of the axle. However, even though the engine was a very small one (from the American point of view), having a displacement of only 80 cu. in., it was found that the weight distribution was unsuitable, and in a later model the somewhat larger engine was placed ahead of the axle, the crankshaft still extending fore and aft.

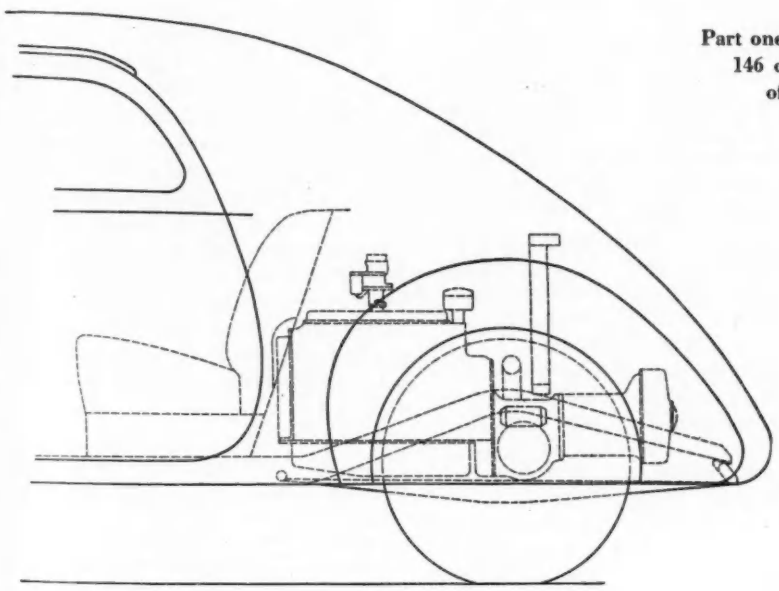


Figure 6 Rear end of rear-engined car

The engine can be arranged parallel with the rear axle, either behind or in front of it, but in that case, too, compactness is desirable, especially if the clutch and transmission are to be mounted in line with the crankshaft. It is also possible to mount the engine longitudinally squarely over the rear axle, but in that case a transfer drive must be provided to carry the power to the primary shaft of the transmission, which latter would be placed below the crankcase and bolted to the final-drive housing. Such a construction involves the use of independent suspension for the rear wheels, so that the differential and transmission will be spring-supported.

Other alternatives consist in placing the engine with its axis in the length of the car, ahead of the rear axle, or in using a very short type of engine and placing it at a considerable inclination either forward or back of the axle or squarely above it. In every case compactness is essential, either because a bulky design would make a suitable weight distribution impossible or because it would encroach too much on the available body space. The need for

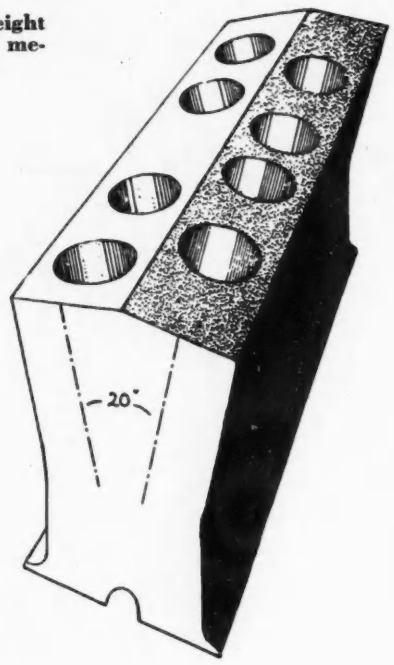


Figure 7 Cylinder block of narrow-V eight cylinder engine with complete mechanical balance.

compactness of the powerplant is well illustrated by Fig. 6, which shows the rear end of a rear-engined car designed by Mr. Hoffman.

The more compact types of engine include the following: V engines with the angle between cylinder banks chosen to given uniform spacing of explosions; narrow V engines in which the angle is made as small as possible without interference between pistons in opposing cylinders; W engines having three banks of cylinders with pistons connected to a common crankshaft; fan-shaped engines in which there are three or more radially arranged cylinders with pistons connected to a common crankshaft; radial engines, "barrel-type" or "round" engines and "flat" or "pancacke" engines. The latter, as a rule, are compact in the direction of the crankshaft axis but not in the direction of the cylinder axes.

Besides compactness, the principal requirements in an engine for either of the two car lay-outs here under consideration are a good mechanical balance and a uniform spacing of explosions. Of course, there are also other very desirable features, such as low cost of manufacture and facility of service, but the former depends so much on details of design and the latter on the location of the engine on the chassis and the manner in which it is housed in, that it is difficult to discuss these features in general terms.

The V-8 engine with 90-deg. angle of V is well known and widely used in current production of cars with conventional chassis layout. This type has been used also to a considerable extent for both front-drive and rear-engined cars, both here and abroad, to which it lends itself well on account of its small overall length. It gives a uniform spacing of explosions and it is in complete mechanical balance so far as primary and secondary inertia forces are concerned. One objection that has been raised against it occasionally is that of inaccessibility of both the engine itself and of the accessories which are usually mounted upon it. This objection does not apply, at least not to the same extent, to the narrow V engine, and considerable interest has been shown in this engine at various times. Its chief exponent has been the Italian manufacturer Lancia, who has built it in both four and eight-cylinder types.

With a narrow V eight-cylinder engine it is evidently impractical to use a two-plane crankshaft, because the advantage of this shaft in its practical applications is that while the secondary inertia forces are balanced against each other and cancel out, the primary inertia forces from the two banks of cylinders combine to make rotary forces, but in order that a constant, uniformly rotating force may result, which can be balanced by the centrifugal forces on counterweights, the two cylinder banks must be at right angles to each other, which is not the case here. With a single-plane four-throw crankshaft the spacings of explosions are uneven, alternate spacings being equal to 180 deg. plus the angle between cylinder banks and 180 deg. minus this angle, so that with a 20-deg. angle between banks, for instance, they are 160 deg. and 200 deg. Moreover, the dynamic balance is very little better than that of the four-cylinder vertical engine; primary forces, of course, are completely balanced, but the secondary forces remain almost in toto. These secondary forces will have both a vertical and a horizontal component and the resultant is in fact a rotary force, but the maximum value of the horizontal component is small as compared with the maximum value of the vertical one. The relative value of the latter is given by the expression $\cos a \cos a/2$, where a is the angle between cylinder banks, as compared with a value of unity for a four-cylinder engine having reciprocating parts of the same total weight and running at the same speed. Thus, for a 20-deg. angle between cylinder banks the maximum value of the vertical component of the secondary unbalanced force will be 0.94 x 0.985 = 0.925, or 92.5 per cent that in the four-cylinder engine.

The disadvantage of unbalanced secondary forces in a narrow V eight-cylinder engine can be overcome by providing it with an eight-throw crankshaft with crank throws in three planes and unevenly spaced. Such an engine has been proposed by Alfred Moorhouse of Detroit. A sketch of the cylinder block and a diagram of the crankshaft are shown in Figs. 7 and 8. Explosions are unevenly spaced, the spacings being 70, 90 and 110 deg. respectively, which is not bad. Both primary and secondary forces are completely balanced. However, if adequate

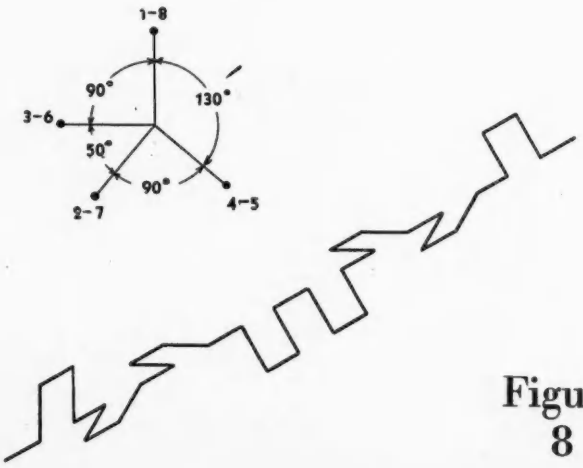


Figure 8 Diagram of crankshaft arrangement for the engine illustrated by Fig. 7.

bearings are provided, the saving in length as compared with an eight-in-line engine cannot be great. The engine certainly cannot be as compact in the lengthwise direction as the conventional V-8, and therefore would seem to be less adapted than the latter to either front-drive or rear-engine cars.

There has been a good deal of speculation regarding the practical advantages of a V-6, if any. Such an engine will give evenly-spaced explosions if the angle between its cylinder banks is 120 deg., and such a large angle certainly does not give a very compact engine, except from the standpoint of length. There would be no free unbalanced forces in such an engine, as those due to each bank of three cylinders (both primary and secondary forces) would cancel out, but there would be both primary and secondary rocking couples. The rocking couples would depend for their magnitude on the distance between the axes of adjacent cylinders, which should be made as small as possible. Just how important these rocking couples are with respect to their effect on the smoothness of operation is difficult to say, for engines having such rocking couples have not been used for automobiles for a great many years. There was, of course, a rocking couple of this sort in Knight engines, due to their valve sleeves, but as these sleeves reciprocated at only half the speed of the pistons and had a stroke of only about one-fourth the piston stroke, the rocking couple, which varies directly as the stroke and as the square of the rate of reciprocations, must have been much smaller than it would be in a six-cylinder V engine. Actually there would be in such an engine two primary rocking couples, each in the plane of the cylinder axes of one bank of cylinders, and they would combine to form a rotating couple.

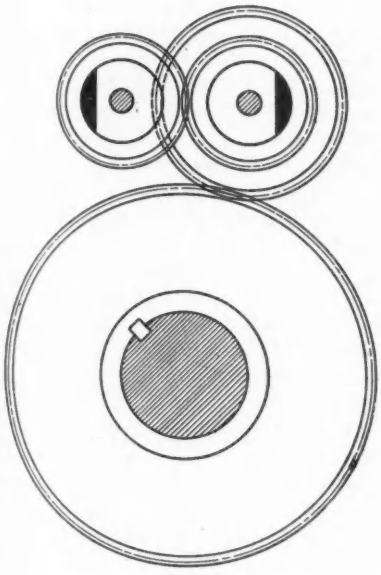


Figure 9 **Arrangement for neutralizing secondary unbalanced forces**

It may be apropos to point out here that rocking couples, both primary and secondary, can be balanced out, the same as free forces. To balance a primary free force we provide the crankshaft with a pair of unbalanced revolving weights revolving in opposite directions and so geared together that their axes of unbalance are parallel to the unbalanced free force when the latter is at its maximum (Fig. 9). Each of the two revolving weights is subject to centrifugal force; the horizontal components of the centrifugal forces on the two weights cancel out, leaving the vertical components, which latter are opposed in direction and equal in value to the force which it is desired to balance. A primary couple evidently can be balanced by two pairs of revolving weights (Fig. 10), one pair at each end of the engine, phased to be in opposition to each other, so that at a moment when one pair produces an upward force the other pair produces a downward force.

Secondary free forces and secondary couples can be dealt with in the same way, except that here the weights must revolve at twice crankshaft speed. This type of balancing device for secondary forces is known as the Lanchester harmonic balancer. However, as this type of balancer for free forces has been used only very little (the one for primary free forces in the engine of the Brush runabout and the one for secondary forces in a four-cylinder Willys Knight and a four-cylinder Westinghouse Diesel engine), it is not likely that the one for balancing rocking couples, which calls for just twice the amount of mechanism, will find much favor. Fig. 9 illustrates diagrammatically a harmonic balancer designed to balance a secondary inertia force. Its two geared-together unbalanced weights revolve at twice crankshaft speed, being driven from the crankshaft through a 2:1 gearset. Fig. 10 shows the arrangement required to balance a secondary couple.

It has been suggested also that a better balance might be obtained in a six-cylinder V-engine by going to six crank throws, but the objection to the eight-cylinder V with eight crank throws that it saves very little on length compared with an in-line engine, holds here also. Presumably, as in the case of the narrow eight-cylinder V, there is a spacing of cranks, dependent on the angle of V, which while it does not give an even spacing of explosions, eliminates both primary and secondary forces and couples. The possible combinations are very numerous and I have not had the time to explore the field.

The W-type of engine has been used extensively in twelve-cylinder form, with four cylinders in each bank, in aircraft practice. The angle between adjacent banks is then 60 deg., so that the two outside banks are spaced 120 deg. apart. Such an engine gives an equal sequence of explosions and also is free from primary inertia forces, because these forces are balanced in each bank of four cylinders. As regards the secondary inertia forces, those due to any bank of four cylinders are, of course, entirely unbalanced in themselves. To find their resultant, it is necessary to resolve the expression for each into vertical and horizontal components and then add the expressions for like components. The expression for the vertical component of the resultant or total secondary force involves the term sin 2θ and the expression for the total horizontal force the term cos 2θ. It is well known that two forces varying as the sine and cosine of the same angle, respectively, and acting along lines at right angles to each other produce a

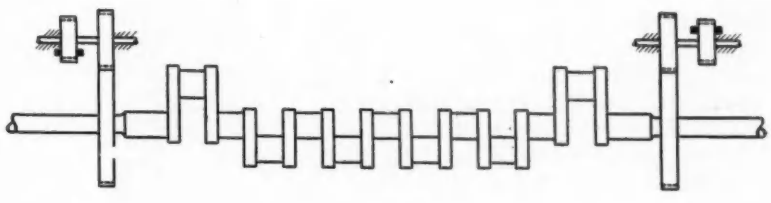


Figure 10 **Arrangement for neutralizing secondary rocking couples.**

rotating force, and if the maximum values of the two forces are equal, then the resulting rotary force is of constant value. In this case, however, the horizontal and vertical components are not equal, the horizontal component being the larger one. A constant rotating force can be balanced by a weight rotating at the same speed as the force, and the vertical component in this case can be eliminated by providing a suitable counter weight rotating at twice crankshaft speed, while the horizontal component can only be reduced by the same amount.

However, a twelve-cylinder engine of any type is hardly suited to a car intended for large-scale production, and one naturally wonders what the firing sequence and the conditions of balance would be if such an engine were cut in half and had only two cylinders in a bank. First of all, it would be impossible to have uniform spacing of explosions. During each two revolutions of the crankshaft there would be four spacings of 120 deg., one of 60 deg. and one of 180 deg. As in each bank of cylinders there is one piston on the downstroke while the other is on the upstroke, there would be no free primary force, but, of course, since the three cylinders whose pistons are connected to one crankpin are offset with relation to the other three, there will be a primary rocking couple for each cylinder bank. The secondary free force will not be eliminated but will be of the same order of importance as in the 12-cylinder W engine. In the six-cylinder, however, there will be a secondary rocking couple which is not present in the 12-cylinder W engine.

An analysis of the opposed type of engine, with a number of crank throws equal to half the number of cylinders was made by the writer some years ago. An even spacing of explosions, together with complete balance of primary and secondary forces and absence of rocking couples can be obtained only with 12 cylinders. One bank of six cylinders, together with a six-throw 120-deg. crankshaft, gives explosions spaced 120 deg. apart, and the two cylinders in opposite banks whose pistons connect to the same crank throw can fire 180 deg. apart, hence each cylinder of the second bank will fire midway between two cylinders of the first, and explosions will be equally spaced. As each half of the engine is entirely free from both primary and secondary forces, the whole engine is completely balanced.

In an eight-cylinder opposed engine with one-plane crankshaft it would be necessary to have explosions occur in two cylinders at the same time, for which reason the torque would be no more uniform than in a four-cylinder engine, and a relatively heavy flywheel would be required. The mechanical balance would be good, as both the primary and secondary forces would be completely eliminated and there would be no couples of any consequence.

With a two-plane four-throw crankshaft a uniform spacing of explosions would be secured, and there would be no free primary or secondary forces, but there would be a pronounced primary couple in the plane of the cylinder axes. This could be balanced only by means of pairs of oppositely rotating weights at opposite ends of the crankshaft, as shown in Fig. 10, and this would probably be too complicated. There would be no free secondary force, as the secondary forces acting on pistons in oppositely located cylinders are in phase and neutralize each other, and while the secondary couple would not be entirely eliminated, owing to the offset of oppositely located cylinders, it would be very small.

A six-cylinder opposed engine with a three-throw, 120-deg. crankshaft would not give uniformly spaced explosions, but spacings of 120, 120, 60, 120, 120 and 180 deg. respectively. There would be no free primary or secondary force, as a three-cylinder engine with three-throw, 120-deg. crankshaft has none, and the "flat Six" is equivalent to two threes. However, there would be rather important primary and secondary rocking couples. The primary rocking couple can be eliminated by using a six-throw, 120-deg. crankshaft similar to that of a conventional six-cylinder vertical engine, and connecting the three pistons of each bank of cylinders to cranks in three different planes. The spacing of explosions is the same as with the three-throw crankshaft. Diagrams representing a side elevation and a plan of the engine are shown in Fig. 11. On the left is a diagram showing the primary inertia forces on the various cranks, in direction and relative magnitude, for the position in which the crankshaft is shown, and it is obvious that these forces balance out and that there is no couple. The secondary forces are similarly represented at the right. It will be seen that the pistons connected to cranks 1 and 6 are at the end of their strokes and the secondary inertia forces on them therefore are at their maximum. Moreover, the secondary force on crank 2 is in the same direction as that on crank 1, and that on crank 5 in the same direction as that on crank 6, though the forces on 2 and 5 are at only one-half their maximum value. These four forces produce a strong couple which is only slightly reduced by a contrary couple on cranks 3 and 4, which is small because of the short distance between the lines of action of these forces. The engine shown in Fig. 11 therefore has the following characteristics. Non-uniform spacing of explosions (120, 120, 60, 120, 120, 180 deg.); no primary free force, no secondary free force, no primary rocking couple, fairly large secondary rocking couple. The chief disadvantage of the type is undoubtedly that on account of the six-throw crankshaft it would be almost as long as a six-cylinder in-line engine.

It may also be worth while to investigate a six-cylinder opposed engine with six-throw crankshaft but uneven spacing of throws so as to give an even sequence of explosions. Cranks 1, 3 and 5 would be at 120 deg. with each other, as would cranks 2, 4, and 6, but cranks 3 and 4, instead of being in line, would be at 60 deg. with each other. There are two possible arrangements of the

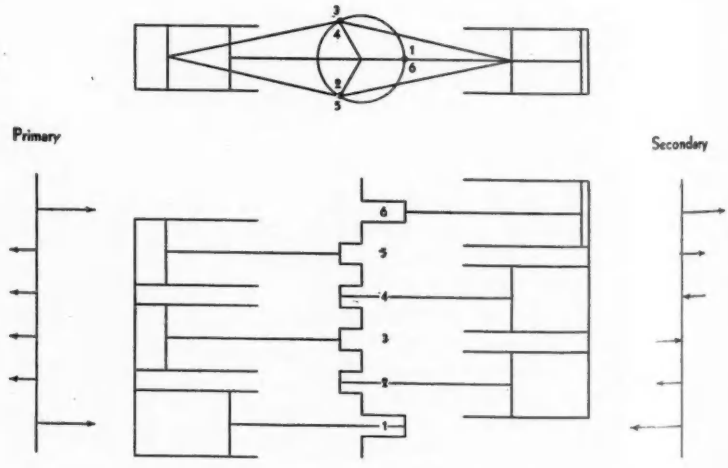


Figure 11 One form of six-cylinder opposed engine and its primary and secondary forces

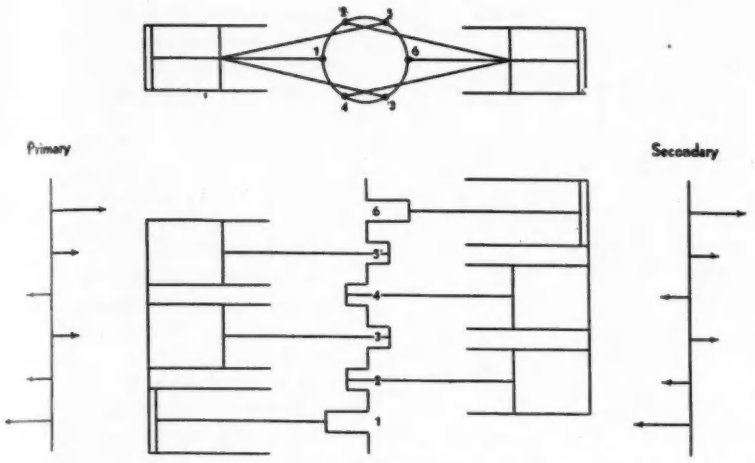


Figure 12 Another form of six-cylinder opposed engine with its primary and secondary forces

crankshaft, as either crank throws 1 and 6 or crank throws 1 and 4 may be opposite each other. The two arrangements are shown in Figs. 12 and 13. Phase diagrams of the primary and secondary inertia forces are shown for both crank arrangements, and it will be seen that both rocking couples are smaller where cranks 1 and 4 are in opposition to each other. The advantages of this type of engine therefore are equal spacing of explosions and absence of free forces, while the disadvantages are the need of six crank throws and a correspondingly long crank, and moderate primary and secondary rocking couples.

If there should be a reversion to the four-cylinder engine (as there has been in Europe), and if a more compact type than the conventional in-line engine is wanted, the choice lies between the 90-deg. V, the narrow V and the opposed or "flat" type. With the four-cylinder, 90-deg. V engine with two-throw, 180-deg. crankshaft, it is impossible to obtain an even sequence of explosions. The spacings will be 90 deg. and 270 deg., which is so irregular that this alone will rule the type out, for if a reversion should be made to an engine with as few as four cylinders, the explosions must be at least nearlly equally spaced, otherwise the engine would be little better than a two-cylinder.

This better spacing of explosions is obtainable with the narrow V engine. For instance, with an angle of 20 deg. between cylinder banks, the spacing between explosions would be 160 deg. and 200 deg. and the irregularity would hardly be noticeable. This type of engine can be made with either a two-throw or a four-throw crankshaft. There are no primary free forces in this engine, as pistons in adjacent cylinders move in opposite directions at any given time. The secondary forces are almost the same as in a four-cylinder vertical engine, except that they have both vertical and horizontal components, the vertical component being slightly smaller than the secondary force in an equivalent vertical four-cylinder engine, and the horizontal component having a small value, depending on the angle between cylinder banks. Where the crankshaft is made with four throws, these are in two planes with the same angle between them as that between cylinder banks. This gives uniform spacing of explosions, but makes the engine longer, as the cylinders have to be spaced further apart to correspond to the longer crankshaft. Balance conditions are substantially the same as with the two-throw crankshaft. The primary free forces cancel out, but the secondary forces remain. In this case the secondary forces from all four cylinders are in phase, reaching their maximum values at the same time, which is not the case in the narrow V engine with a single-plane crankshaft. But while the secondary forces from all four cylinders are in phase, they cannot be added together directly because of the angle between their lines of action. In this engine, therefore, the resultant secondary force is greater than in the engine with a single-plane crankshaft, but slightly less than in an equivalent four-cylinder vertical engine.

Of the four-cylinder engines to be considered there remains only the "flat" type, which is generally made with a three-throw crankshaft, the central throw having one piston in each of the two cylinder banks connected to it. In this engine explosions are uniformly spaced at 180 deg. intervals. There are no free forces, either primary or secondary, because pistons in oppositely located cylinders and connected to cranks at 180 deg. always move at exactly the same speed and therefore are subject to the same inertia forces, in opposite directions. There is also no primary rocking couple, as may be seen from Fig. 10, because primary inertia forces due to cylinders 1 and 4 are in the same direction and those due to cylinders 2 and 3 in the opposite directions, and the resultants of the two pairs of forces are equal and opposite and act along the same line. There is a small secondary couple, however, because, as shown in Fig. 14, the secondary forces due to cylinders Nos. 1 and 3 are in phase, while those in Nos. 2 and 4 are in the opposite phase, and the resultants

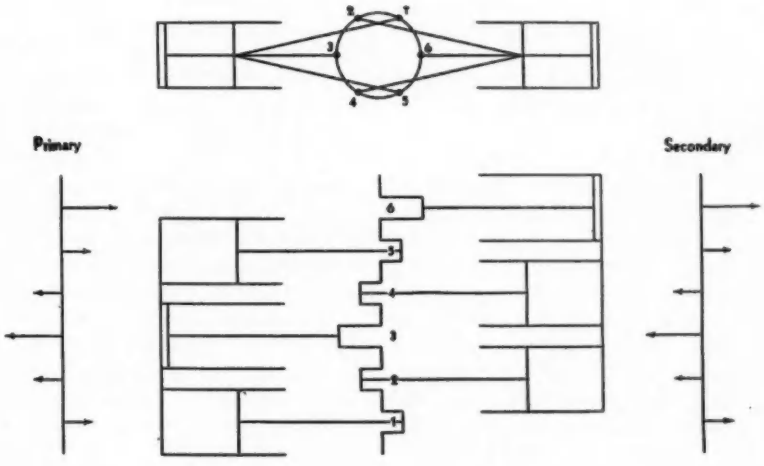


Figure 13 A third form of six-cylinder opposed engine with its unbalanced forces

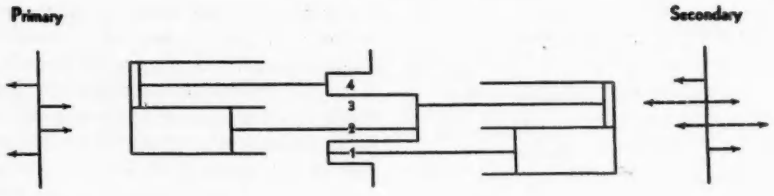


Figure 14 Four-cylinder opposed engine and diagrams of its inertia forces

(shown dotted) of the two pairs of forces respectively do not act along the same line, but along lines whose distance apart is equal to the offset of the two cylinder blocks, which will be equal to the length of a big-end bearing plus the thickness of the long crank arm.

Because of its excellent balance, an engine of this type would seem to be well suited to small cars with either rear-engine mounting or front drive, as a very suitable weight distribution should be obtainable with the engine on one side of the axle, the transmission on the other side, and the final drive gear (either worm or hypoid) in between.

Engines of this type are being used at present for motorcycle, marine and aircraft work, and the crankshaft is provided with only two main bearings, to make the engine as light and compact as possible. However, if it were to be operated at really high speeds, which the excellent mechanical balance would permit of, it would have to have at least three main bearings, which would add to the length by an amount equal to the length of the intermediate main bearing plus twice the thickness of the crank arms adjacent to this bearing. Moreover, to reduce the bearing loading, all short crank arms should be provided with counterweights.

Radial engines have long been built for aircraft application, from which it may be judged that their balance is relatively good, for it would hardly do to mount a poorly balanced engine on such a light structure. Four-stroke engines with cylinders in a single plane must have an uneven number of cylinders in order to give equally spaced explosions. These radial engines have been built with as few as three and as many as nine cylinders in a single row. With a small number of cylinders it is *possible* to connect all of the pistons directly to the single crankpin, each connecting rod being provided with an arc-shaped head, these heads encircling the crank pin and leaving sufficient space between them so as not to interfere with the free angular motion of the connecting rods. Bearing rings encircling the heads of the connecting rods hold them in place.

Where this type of crank train is used, the primary inertia forces combine to make a constant, uniformly rotating force which can be canceled out by the centrifugal forces on a pair of counterweights secured to the crank arms. Secondary forces are not balanced out. As shown in Fig. 15, in a three-cylinder radial, when one piston is at the outer end of its stroke and the secondary force due to it is therefore a maximum and directed away from the crankshaft axis, the secondary forces on the other two pistons are at half their maximum value and directed toward the crankshaft axis. The secondary force due to the reciprocating mass in the upper cylinder may be represented by the expression $A \cos 2\theta$, where A is a coefficient depending on the weight of these parts, the ratio of connecting-rod length to length of stroke, and the speed of revolution of the crankshaft. This force, of course, acts in a vertical direction and therefore has no horizontal component. θ represents the crank angle, which is measured from the top dead center position. The secondary inertia force due to the reciprocating masses in the lower right-hand cylinder is then expressed by $A \cos 2 (\theta + 240°)$ and that due to the reciprocating masses in the lower left-hand cylinder by $A \cos 2 (\theta + 120°)$, 120 deg. being used here because it is the same as 480 deg., or twice the crank angle when the crank is in the dead center position with relation to the lower left-hand cylinder. As all of the three secondary forces act in different directions, it is necessary to resolve each into a vertical and a horizontal component and then add like components. The three vertical components have the following values:

1. $A \cos 2\theta$
2. A (— sin 30°) (cos 2θ +240°)
3. A (— sin 30°) (cos 2θ + 120°)

By introducing the expressions for the cosine of the sum of two angles we get

1. $A \cos 2\theta$
2. A (— sin 30°) (cos 240° cos 2θ — sin 240° sin 2θ)
3. A (— sin 30°) (cos 120° cos 2θ — sin 120° sin 2θ)

The functions of the various angles have the following values:

(— sin 30°) = — 0.5; cos 30° = 0.866; cos 240° = — 0.5; sin 240° = — 0.866; cos 120° = — 0.5; sin 120° = 0.866

Substituting these values we get for the three vertical components

1. $A \cos 2\theta$
2. $0.25\ A \cos 2\theta$ — $0.433\ A \sin 2\theta$
3. $0.25\ A \cos 2\theta$ + $0.433\ A \sin 2\theta$

Adding the three together we get for the vertical component of the total secondary force

$1.5\ A \cos 2\theta$

The horizontal components of the secondary forces due to the reciprocating parts in the two lower cylinders may be written:

2. cos 30° A cos $(2\theta + 240°)$
3. — cos 30° A cos $(2\theta + 120°)$

Expanding the right-hand terms we get

2. cos 30° A (cos 240° cos 2θ — sin 240° sin 2θ)
3. — cos 30° A (cos 120° cos 2θ — sin 120° sin 2θ)

Introducing numerical values for the functions of the various angles we get

2. $0.866\ A$ (— 0.5 cos 2θ + 0.866 sin 2θ)
3. — $0.866\ A$ (— 0.5 cos 2θ — 0.866 sin 2θ)

which upon eliminating the parentheses gives

2. —$433\ A \cos 2\theta + 0.75\ A \sin 2\theta$, and
3. $0.433\ A \cos 2\theta + 0.75\ A \sin 2\theta$,

which when added together give

$1.5\ A \sin 2\theta$

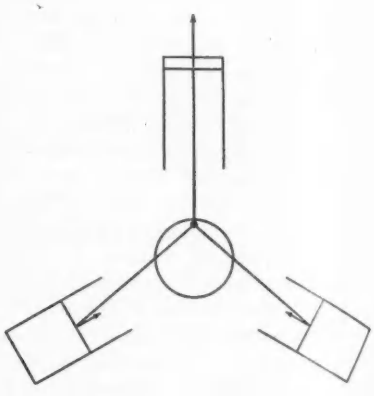


Figure 15 Diagram of three-cylinder radial engine

We thus see that the vertical component of the total secondary force varies as the cosine and the horizontal component as the sine of twice the crank angle and the two components combine to give a single constant rotary force, 1.5 *A*, which can be balanced by means of a balancing weight rotating at twice crankshaft speed.

The crank arrangement considered in the foregoing has been very little used, undoubtedly because with a multi-cylinder engine the bearing area of each connecting rod on the crankpin would be inadequate. Radial engines usually have one master connecting rod, which has its bearing on the crankpin, and so-called "link" connecting rods for the other cylinders, these being articulated to the master rod close to its big-end bearing. With this arrangement the strokes of the different pistons are all different. The problem of evaluating the total primary and secondary forces for such an engine is quite complicated, as a number of new factors are introduced, namely the length of the link rods, the angular spacing of the link rods, and the distance between the crankpin-bearing axis and the link-rod bearing axes. Owing to the differences in the lengths of stroke, the primary forces cannot be completely balanced by counterweights on the crank arms, but, as previously stated, the degree of unbalance will not be large. The resultant secondary force also is no longer a constant rotary force, but this probably would not be balanced in any case. In a radial engine, owing to the considerable number of reciprocating masses connected to the single crank, the counterweights must be quite heavy.

The radial engine has a number of advantages which make it look rather attractive as a vehicle engine. The principal ones are its small length and the low weight due to its short crankcase, crankshaft, etc. The question arises as to the best arrangement on the car. It could hardly be arranged with the crankshaft axis horizontal and in line with the axis of the differential, as that would bring the lowermost cylinders too close to the ground. This difficulty might be overcome by the use of an over-mounted worm final drive. In connection with the problem of ground clearance, there arises the problem of the diameter required for a radial engine of any given output. The greater the number of cylinders, the smaller the individual cylinder and the smaller, consequently, would be the diameter of the engine. Practically all aircraft radial engines have valves in the head, but this adds materially to the outside diameter, and for automobile use L-head cylinders probably would be preferred. With L-head cylinders of 3¼-in. bore and 3¾-in. stroke (218 cu. in. for a seven-cylinder) the over-all diameter would be of the order of 25 in.

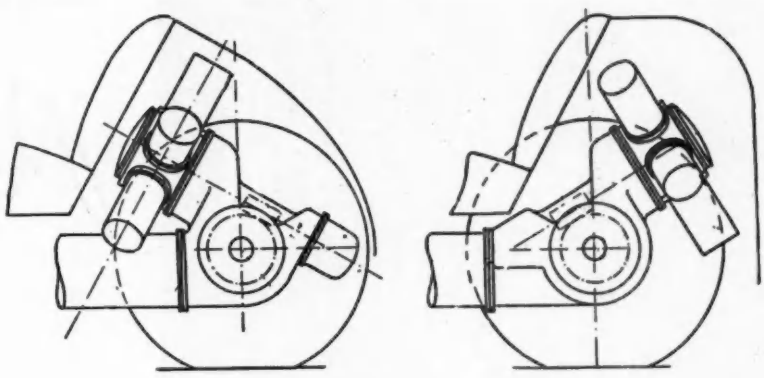


Figure 16 Two arrangements of rear-mounted radial engines.

It has been suggested to place the radial engine at an angle of approximately 45 deg. to the vertical, either in front of or behind the rear axle, and drive to the axle through an over-mounted worm gear, the worm-shaft being made hollow and the primary shaft of the transmission extended through it, so that the transmission can be located on the opposite side of the axle from the engine. Two illustrations from a French patent to Porsche in which this suggestion is made are reproduced in Fig. 16. It has also been suggested to arrange a radial engine on a vertical axis, this being similar to a plan followed in the Adams-Farwell, one of the early American cars, which was equipped with a rotating-cylinder engine. In the latter the drive was from the engine block through bevel gears to a transverse shaft on which the clutch and transmission were mounted.

Before the radial engine could be adopted as a powerplant for production cars, numerous design problems would have to be solved. It is not very likely that much help could be gained from aircraft practice, as aircraft radial engines have all cylinders made separate and mounted on a light-alloy crankcase which itself is cast in two or three sections. For an automobile engine a block construction, with all cylinders and the barrel-type crankcase in a single casting, would seem to be the most practical one. Entirely new production equipment would be required, such as cylinder boring machines with radial spindles. Nearly all radial engines built so far have been of the air-cooled type, but for automobile use, especially where the engine is to be mounted in the rear, water cooling would be preferred. There would be numerous problems in connection with carburetion and manifolding, cooling and lubrication. For instance, the water outlets from all cylinder jackets would have to be at the highest points, in order to prevent the formation of steam pockets, and in an engine with a horizontal or nearly horizontal axis, this would be at the head end in one or two cylinders and at the opposite end in others. Inlet-manifolding problems would have to be solved on an entirely new basis, and quite likely the use of a blower, with its impeller mounted on the crankshaft, would be necessary in order to assure even fairly uniform distribution. One disadvantage of the engine is the relatively large amount of "plumbing" required by it—water inlets to and outlets from all cylinders, and inlet and exhaust connections to individual cylinders. Problems of distribution, cooling and lubrication would evidently be simplified if the engine were mounted on a vertical axis, as gravity effects would then be alike for all cylinders.

There is some doubt as to whether an engine of the radial type could be run as fast as an equivalent in-line engine for the reason that a single crankpin bearing has to support all of the inertia loads. On the other hand, an engine of given displacement could certainly be built much lighter in the radial than in the in-line form, as there are important weight savings on the crankcase and the crankshaft. The short crankshaft would seem to eliminate all danger of serious torsional vibration, because of its inherent much greater rigidity, but torsional vibration has given some trouble in aircraft engines of the radial type. The absence of a long propeller shaft in a front-drive or a rear-engined car would eliminate another potential cause of vibration, so that if the design were once thoroughly worked out a very smooth-performing vehicle might result from the application of the radial engine.

Production Lines

Metal finishing on the production line of Hudson Body plant

Soluble Oils

A visit to an important parts plant recently disclosed the interesting fact that this company had found it possible to switch almost exclusively to soluble oils for most metal-cutting operations. They have standardized on two mixtures—12 to 1 for metal cutting, and a weak mixture for grinding. Two new four-spindle automatics are using this soluble mixture and it is found on all broaching machines—surface and internal broaching, the only exception being a surface broaching set-up for finishing where a sulfurized oil is continued. Several years ago, we commented on the fact that Chevrolet had found it feasible to adopt a 15 to 1 soluble oil mixture for heavy broaching operations. These experiences dovetail to prove that the old rule-of-thumb ideas concerning cutting fluids have gone by the board. Simplification is the ruling principle and large metal-cutting establishments will find considerable profit in a study of the new order of things.

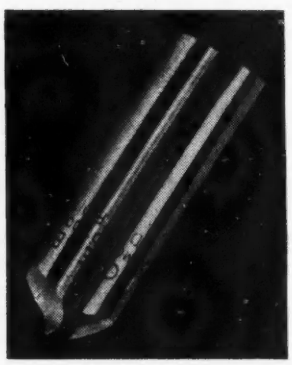
Electrification Forum

The Westinghouse Electric and Mfg. Co. will sponsor a second Machine Tool Electrification Forum at the East Pittsburgh Works, April 19-22. The forum will discuss "New Methods and Designs for Machine Tool Electrification."

Papers on the subject of special and difficult problems will be presented by representatives of machine tool builders as a special feature of the forum. Talks will also be given by Westinghouse works, application and design engineers. Inspection trips through the East Pittsburgh and Nuttall Works will be included in the program.

Stands Up

The great utility of correct application of the industrial diamond tool is indicated by the production record of a Koebel diamond tool used on an Ex-Cell-O precision boring machine in a well-known Detroit plant.



The operation was finish-boring the wrist pin holes in aluminum alloy pistons, and despite the abrasive nature of the alloy, it claimed that the tool bored more than 200,000 pistons before it had to be reshaped. In this operation, the tolerance of the hole was maintained within 0.00015 in.

After this period of service the diamond was in no sense "worn out." It required only re-lapping to the correct radius to prepare it for further service.

Auto Radio

Judging by the experience of some factory electrical engineers, antenna location and design is by no means a completed problem. True, many refinements have been made for 1937 but the solution, apparently, still does not completely satisfy the engineer despite the fact the present antenna gives much better performance than before. In the opinion of some well-informed radio experimenters, the overhead roof aerial offers the real solution so far as good radio reception, free from tire static, is concerned. However, factory engineers have been unable, so far, to reconcile ideal aerial design with satisfactory appearance. Evidently if an individual owner prizes good radio reception above external appearance he can be taken care of very well. Here is a neat problem for some one who is willing to reconcile its divergent requirements.

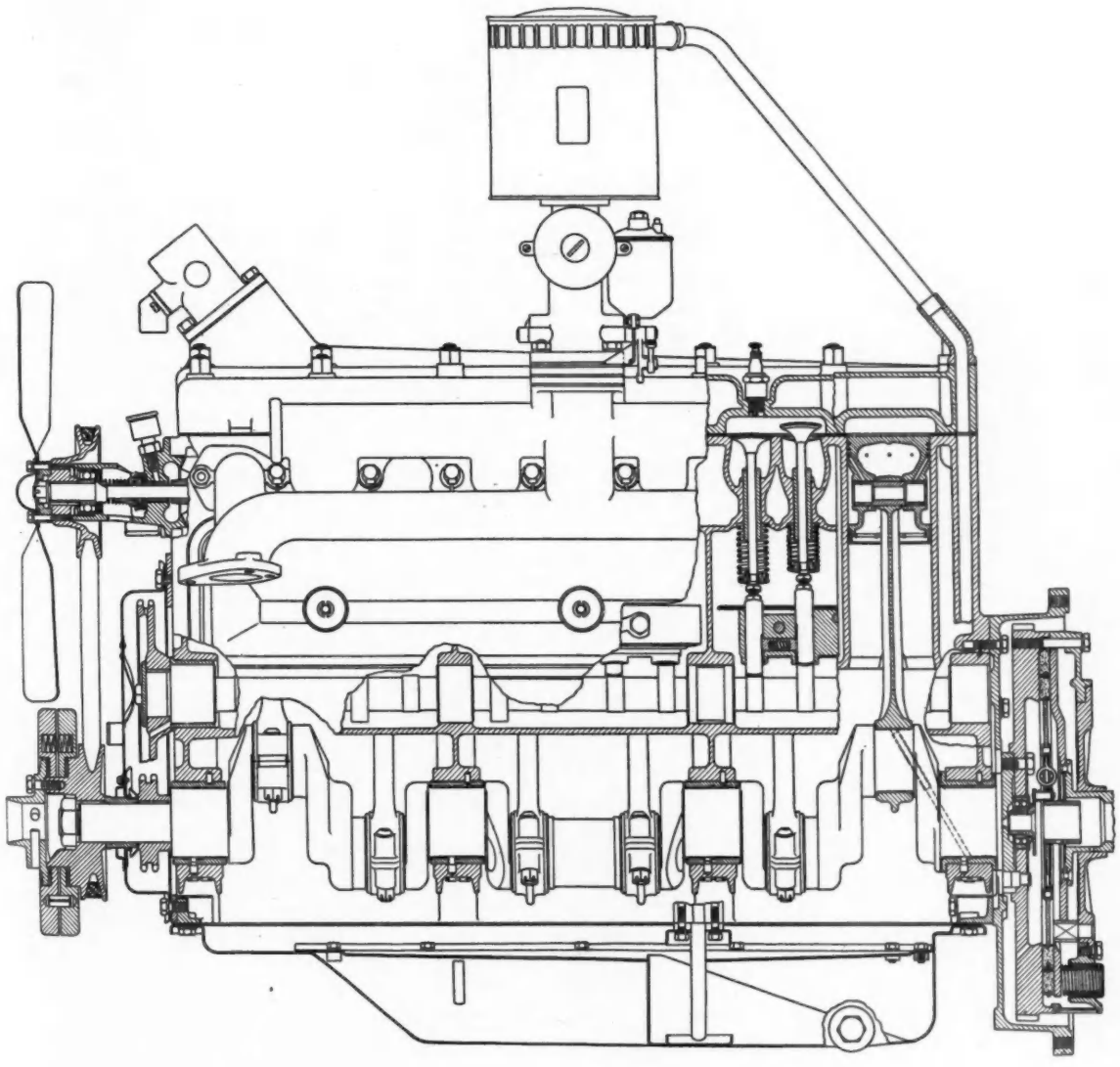
Insulates Aerial

One of the fine problems for certain 1937 cars was the development of insulators for running board antenna mounting. A suitable dielectric is not hard to find but this application required a combination of dielectric properties and mechanical strength as well. One of the car builders is using insulators molded from No. 6260 Bakelite with a Rogers board core and at assembly the insulator is backed up by a ⅜-in. steel strip to prevent warpage of frame and stephangers. The construction is so strong mechanically that the ⅜-in. SAE bolts used for attachment can be tightened up sufficiently to strip the thread without damaging the insulator.—J. G.

MANUFACTURING MANAGEMENT METALLURGY

Morris Six-Cylinder "25-Hp." Engine

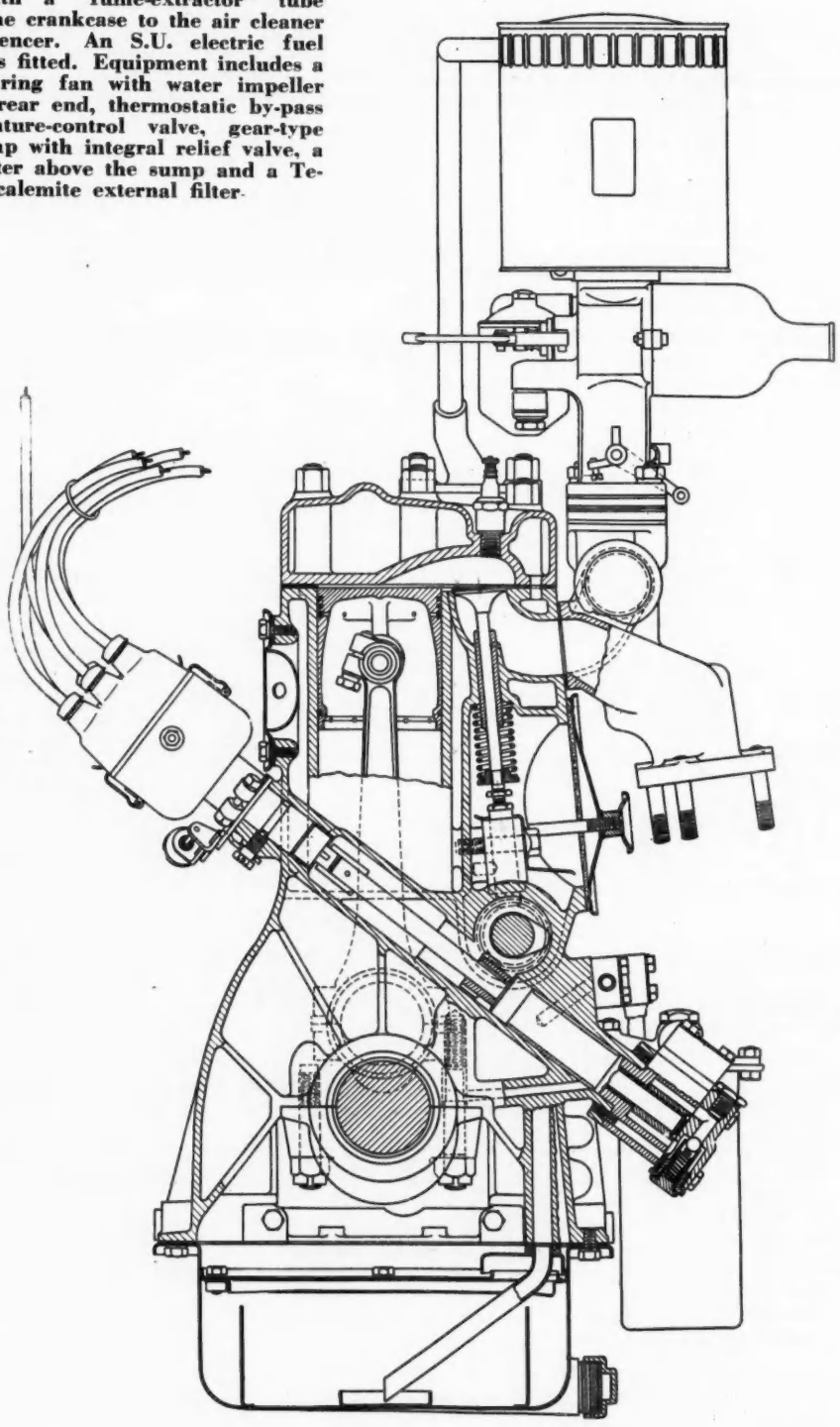
This British engine has a bore and stroke of 82 by 110 mm. (3.23 by 4.33 in.), giving it a displacement of 212.6 cu. in. The compression ratio is 5.9 and the engine develops 79.5 b.hp. at 3700 r.p.m. Pistons are of aluminum alloy Main bearings are 2 7/16 in. in diameter and all four of them are 2 in. long. Connecting rod bearings are 2 3/16 in. in diameter and 1⅜ in. long. Connecting rods have a center-to-center length of 9½ in.



No. 14 in the AUTOMOTIVE INDUSTRIES Series of Engineering Drawings

Morris Six-Cylinder 25-Hp. Engine

This British engine is equipped with a piston-type S.U. downdraft carburetor, with a "fume-extractor" tube from the crankcase to the air cleaner and silencer. An S.U. electric fuel pump is fitted. Equipment includes a ball-bearing fan with water impeller at the rear end, thermostatic by-pass temperature-control valve, gear-type oil pump with integral relief valve, a tray filter above the sump and a Tecalemite external filter.



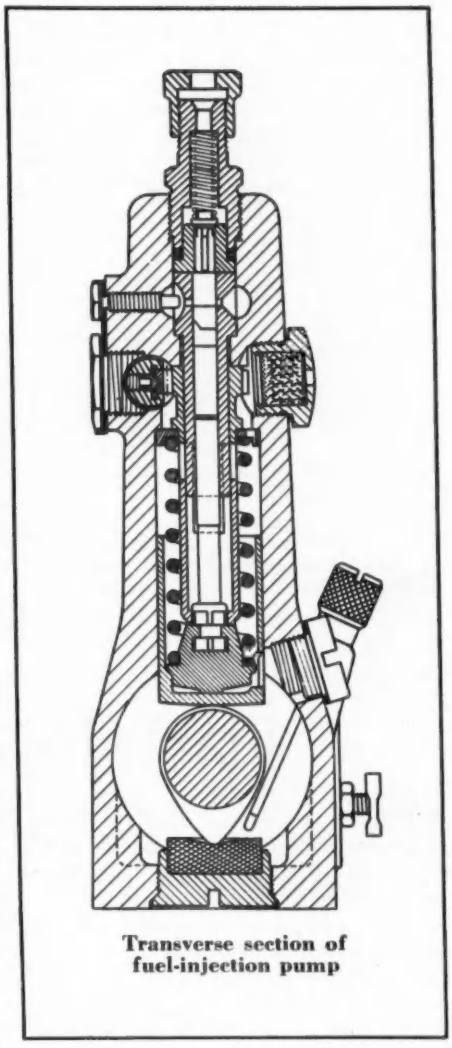
Timken Injection Pump for Diesels

DETAILS of its injection pump for Diesel engines, on which development work has been in progress for the last three years, have just been released by the Timken Roller Bearing Co. The pump is being made in two sizes, but each size comes in a considerable range of plunger diameters, as well as for one, two, and six-cylinder engines. One size of pump has a plunger-diameter range of 4-9 mm., the other of 5-11 mm. Some of these pumps have been in use for a year on commercially-operated Diesel-powered trucks, buses and tractors.

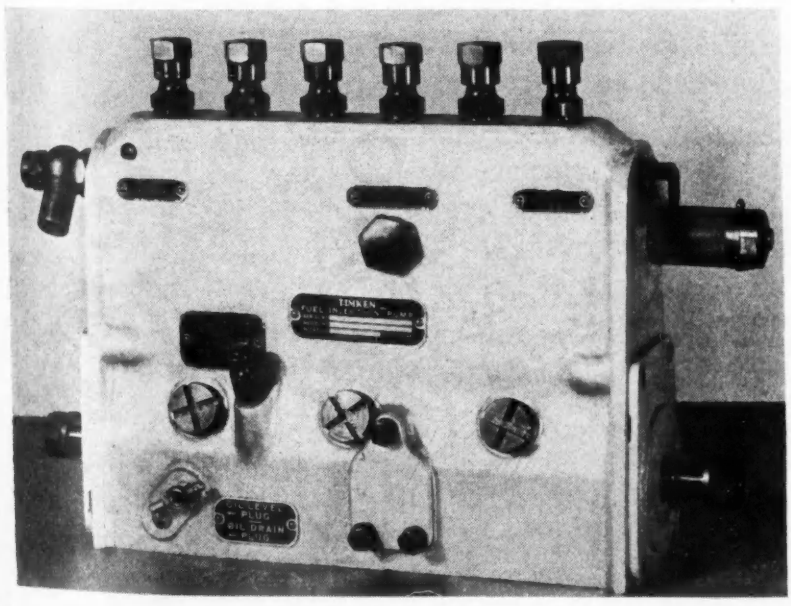
As will be seen from the accompanying diagrams, these pumps are of the cam-operated, helical-plunger type. The metering elements are adjusted at the factory and sealed. When the plunger is at the lower end of the stroke, the cylinder receives a charge of fuel from the feed line, which is kept filled by a transfer pump connected to the fuel tank. Delivery of fuel to the high-pressure line starts as soon as the piston covers the inlet port, and ends when the upper helical edge of the annular groove in the piston opens the overflow or by-pass port on the opposite side of the pump cylinder wall. The effective delivery stroke may be varied by turning the piston in its barrel, as this varies the point of the stroke at which the overflow port is uncovered.

An outstanding feature of these pumps is the use of a "constant-velocity" form of cam. The rate of fuel delivery is thus maintained constant over the greater part of the delivery period. Of course, the constant-speed part of the stroke is preceded by a period of acceleration and followed by a period of deceleration. As a means of adjusting the amount of fuel delivered per cycle there is provided a rack rod which extends horizontally along the rear face of the pump and meshes with gears on the upper ends of the driving sleeves. The upper or driving sleeve for each piston may thus be rotated on the barrel of the pump. This upper sleeve is tongue-and-groove connected with the lower sleeve, which fits on the piston. As the upper sleeve is rotated on the barrel, the lower sleeve rotates the piston, thereby changing the position of the helix with respect to the relief port.

Surrounding these sleeves are light helical springs that serve to retract the pistons and hold the driving sleeves in position. The tappet cup is so designed as to provide a minimum of wearing surface between the cam and the pump plunger, and is made of a new type of graphitic steel recently developed by the Steel and Tube Division of the company. This steel, which contains free graphite, can be heat treated to provide great wear resistance, and the graphite is said to act as a lubricant retainer in the polished surface.



Transverse section of fuel-injection pump



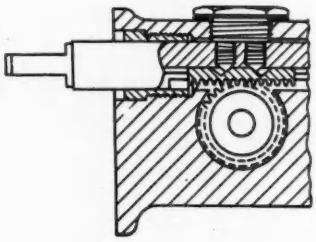
Timken six-unit fuel-injection pump

The tappet and spring design is such as to eliminate the need for an adjusting screw between the plunger and the spring. The cam being offset lengthwise with relation to the tappet axis, the tappet is rotated by the cam, and wear on it is thus distributed. Absence of adjusting means at this point also keeps down the weight of the reciprocating parts and reduces the stress in the springs.

To adjust the individual metering sleeves on the plunger, the rack rod is provided with a series of detachable rack sections which mesh with the gears of the metering or driving sleeves. These are adjusted longitudinally on the rack rod and locked in position by

means of two horizontally-spaced parallel screws with conical points. The space between the two screws is less than that between the conical recesses in the movable sections, and by loosening one screw and tightening the other, each section can be adjusted lengthwise very accurately. Provision for adjusting these blocks is made at the back of the pump housing, but the adjustment should be made only at the factory or by an authorized service man, and the back opening is deliberately made to discourage adjustments in the field.

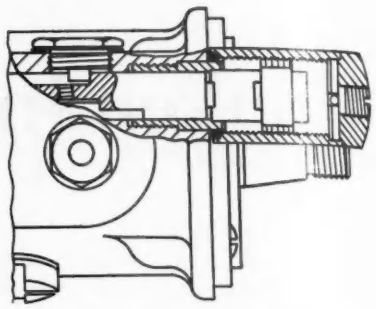
A stop for the rack rod which controls the metering sleeves definitely limits the maximum amount of fuel delivered to the engine. At one end of the control rack there is a knurled nut which controls the stop. By means of this nut the maximum amount of fuel can be limited in accordance with the altitude at which the engine is working. A number of cotter pin holes are drilled through this nut, and the space between adjacent holes represents the change in adjustment required for a change in altitude of 1000 ft.



Horizontal section through rack, showing means provided for adjusting individual pumps

The piston rotating mechanism has several advantages. The toothed rack sections may be easily removed and replaced when worn or damaged. They may also be adjusted independently of each other to obtain uniform angular adjustment of all pistons without removing the rack bar or dismantling the pump.

As these pumps must operate under pressures running as high as 10,000 lb. per sq. in., and the clearance between the plunger and the pump barrel is only 0.00003 in., the housing had to be designed for great stiffness. Alloy steels are used for the various parts. For convenience in installation, these pumps are made to fit standard bases, and all connecting parts conform to standard dimensions. All parts are interchangeable, and stocks of replacement parts will be conveniently distributed throughout the country.



Horizontal section through rack stop, by which adjustment for altitude can be made

Type A, the smaller pump, which uses plungers of 4 to 9 mm. diameter, is adapted for use on engines of up to approximately 150 hp. and operates at engine speeds of up to 4000 r.p.m. The B size, which uses plungers of 5 to 11 mm. diameter, is ordinarily used on engines of from 110 to 250 hp. operating at speeds of up to 3000 r.p.m.

Reversible Accessory-Driving Mechanism

IN the manufacture of aircraft engines for the general market, a difficulty arises from the fact that different aircraft builders want the engine to turn in different directions. It has become customary to provide such engines with reversing means, but that usually necessitates the provision of engine accessories which are adapted for operation in the opposite direction from the standard accessories. A patent which has been assigned to Continental Motors Corporation obviates the necessity for doing this.*

The patent covers the combination of a crankshaft driving gear, an accessories shaft driven gear, and two intermediate gears which can be used selectively. When the larger of the intermediate gears is used, the drive is from the driving gear to the intermediate gear, to the driven gear. In order to obtain a reverse drive, the smaller of the intermediate gears is placed in the position of the larger one, and by means of an eccentric stud it is brought into mesh with the driving gear. The larger of the intermediate gears is placed on a stud to one side, and it then meshes with both the first intermediate gear and the driven gear, hence the drive is then from the driving gear to the first intermediate gear, to the second intermediate gear, to the driven gear. As there are two intermediate gears in this case the drive will be reversed. Therefore, all that is necessary to effect a reversal of the drive is to interchange the two intermediate gears and turn the eccentric stud in such a way as to bring the first intermediate gear into proper mesh with the driving gear. When only one of the intermediate gears is used the other rotates idly on its stud.

* Patent No. 2,051,568. Reversible Accessory-Driving Mechanism for Engines. Harold E. Morehouse, Detroit, Mich.

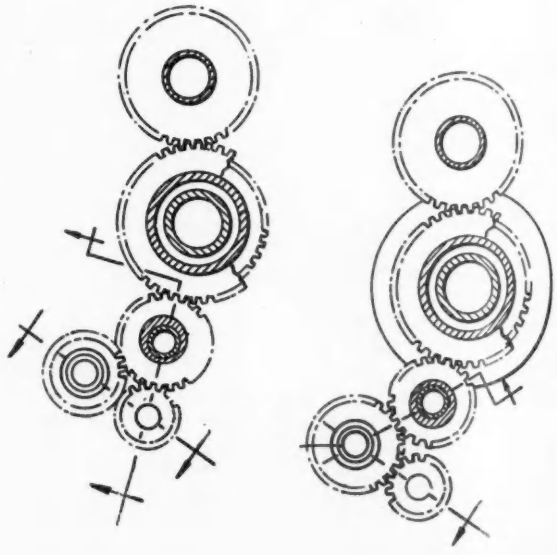


Diagram of the Morehouse accessory - driving mechanism